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Latin-American Studies, IX

Basic Industries in Texas and Northern Mexico

Conference Sponsored by the Institute of Latin-American Studies of The University of Texas
June 9–11, 1949

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THE ROLE OF NACIONAL FINANCIERA IN THE DEVELOPMENT OF INDUSTRY IN NORTHERN MEXICO

PRAXEDES REINA HERMOSILLO

Assistant Director, Nacional Financiera, Mexico

My invitation to participate in this conference was a source of profoundest satisfaction. In the first place, my subject, "The Role of Nacional Financiera in the Industrialization of Northern Mexico," gives me an opportunity to discuss some of the most dynamic aspects of life. In the second place, I believe the universities are the proper custodians of the truly dynamic life; particularly is this the case with regard to the cultural aspects of life. As universities become international, their trusteeship of the dynamic elements of cultural interaction becomes more real and significant. The work of the professors who organized this conference has a distinguished antecedent in American history: the voice of a poet at the time when he had reached his true stature, a poet who freed himself from the limitation of a country and of a race in order to open his spirit to universal life. I refer to Walt Whitman, who, in celebration of the successful completion of important works of industrial development, such as the opening of the Suez Canal and the transcontinental American railroad, exclaimed: "The earth to be spann'd, connected by net work. . . . The people, brothers and sisters. . . . The races, neighbors. . . . The distant brought near, The lands to be welded together."[1]

The basic objections of an industrial policy are even more important than some of its results, for if these are inadequate, the economic future of a nation is endangered. So, before speaking of the results of financing, I will deal with the subject of the industrial policy followed by Nacional Financiera as an official credit institution of the Mexican Government.

The rules governing that policy are the following:

First.—In its promotional as well as credit-granting functions, Nacional Financiera must direct its resources toward creating and strengthening enterprises in the national economy that:

a) Use unexploited or insufficiently exploited natural resources.
b) Seek technical improvements or a substantial increase of production in the most important branches of the national industry.
c) Contribute to improve the balance of payments, either by freeing the country of non-essential imports or promoting the development of the production of exportable goods or, in general, the development of industries that cause an inflow of foreign exchange.

Second.—Nacional Financiera must operate in relation to the above-mentioned activities within the limits of an anti-inflationary policy.

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[1]Walt Whitman, *Passage to India*, p. 342 (The Viking Portable Library).

Third.—Nacional Financiera must in all cases endeavor to obtain private co-operation in the promotions it undertakes, and before granting credits it must assure itself that the promoters have furnished the enterprises with the maximum resources they can reasonably obtain under the circumstances.

Fourth.—Nacional Financiera may purchase private securities if the enterprises fall under any of the provisions of Rule 1, above, or it may seek to stabilize by open market operations the prices of high-grade bonds, except in cases of securities underwritten by Nacional Financiera.

Fifth.—Nacional Financiera is in charge of everything related to the negotiation, granting and admininstration of long and medium termed credits from foreign sources: private, Government or intergovernmental institutions, including the International Bank for Reconstruction and Development, when the granting of the loan requires the guaranty of the Federal Government. This rule does not include the credits obtained by the "Banco de Mexico" for monetary purposes.

Sixth.—To finance the purchase of agricultural machinery in order to co-operate in the fulfillment of the President's agricultural production program.

Faced with the fundamental rules mentioned before, the foreign observer would immediately notice the following:

I. The Mexican Government, an economic and political unit, is intensely concerned about the industrial and agricultural development of the country, stimulating and regulating private investment.

II. To invest in activities that are considered fundamental, the Government has created institutions like Nacional Financiera, as other governments have established different types of agencies or corporations to carry out the economic development of their countries. Nacional Financiera is essential to the state and the nation whose development it fosters.

III. According to the regulations mentioned before, Nacional Financiera must aid economic development, particularly in those fields in which its participation is essential to the basic steps. The American observer surely understands the importance of the correct exploitation of natural resources and of manufacturing industries, especially if he will bear in mind the composition of the national income of his country.

IV. Nacional Financiera operates without excluding private capital, but stimulating and complementing it when necessary. If private capital is unavailable, public funds are invested in types of enterprise deemed essential to the national welfare so that within the limitations of the capital funds which Government may conveniently mobilize, basic industrial development is not halted. In this way the ancient problem of what concerns the State and what should be left to individuals is solved. A realistic conception of the State is created; aside from the regulative

function, the State grants direct aid to fulfil the essentials of an economic life beyond the point reached by private enterprise. It is a complementary or creative aid, depending upon the prevailing circumstances.

V. Nacional Financiera's resources derive fundamentally from its capital stock of $100,000,000.00 (one hundred million pesos); from the sale of the securities it issues: Certificates of Participation and "Títulos Financieros," whose present circulation amounts to $350,000,000.00 (three hundred and fifty million pesos); and from domestic and foreign loans.

Generally speaking Nacional Financiera's resources are directed toward the basic industrial development through credits for machinery, equipment and capital work, or the purchase of different types of securities. The purpose of this financing is not to make an entrepeneur or an owner out of Nacional Financiera but only an efficient promoter. If the foreign observer finds that Nacional Financiera is stockholder in some important enterprises, he must know that this is usually a temporary arrangement.

VI. Financing through credits is based on two principles: first, not to create a monetary expansion and, second, not to become a burden to the initial and future development of industries. The first one avoids inflationary consequences, and the second favors industrial development.

Financing by purchasing securities is related to the fundamental industries of the national economy. Economic history has shown that when industrial enterprises have internal financing sources, they do not utilize external sources—that is to say, they do not resort to the securities market, but reinvest their earnings. This situation is called "mature economy" as it was named in the nineteen thirties in United States. In Mexico such a maturity has not been reached and industrial enterprises with insufficient accumulated surplus offer securities on the capital market. If private funds are not sufficient, Nacional Financiera cooperates in placing the issue, aiding the existence and development of the securities market. This type of operation exceeds that of an Investment Bank operating on a commission basis or that of an Underwriter that purchases securities at its own risk, mainly because Nacional Financiera is an institution whose policy is to increase the volume of savings and accelerate capital formation. Nacional Financiera through its Certificates of Participation has established a technical-financial procedure that allows the increase of savings and their investment with productive purposes. The Certificate of Participation represents marketable industrial securities that principally form the "Common Fund" of each issue. Therefore, the Certificate of Participation, guaranteed by Nacional Financiera, has become a way of distributing industrial bonds among the public. This is why foreign observers have probably heard that to purchase a Certificate of Participation amounts to aiding the industrialization of the country. The extant issues of this type of securities, initially floated

in 1941, amount to $346,000,000.00 (three hundred and forty-six million pesos).

Another function of Nacional Financiera, alluded to above as open market trading, is carried out by the purchase of high-grade securities when the market lags.

The American observer will now be able to appreciate the importance of Nacional Financiera in regard to the formation of an adequate capital market that combines two essential forces: savings and investment. And if at present this mechanism lacks intensity, it is because it has not had time to develop itself. Until after the first world war, savings in the United States were inferior to the supply of securities from the industrial expansion, but there was no lack of material for a securities market supported by commercial banks, the Investment Bank and the Underwriters.

After World War I, savings increased and in the nineteen twenties, the most intense manifestation of finance capitalism was produced.[2]

VII. The American observer also can easily notice that even if national resources are not sufficient to carry out the industrialization of fundamental enterprises, the State does not rely on monetary expansion or on the creation of new inflationary bank money that would impoverish large sections of the population. Countries with a poor industrial development are faced with an impressive dilemma: to base industrialization on voluntary savings or to go beyond these savings, controlling the inflationary effects it might cause. But when one has to satisfy vital needs to stay alive, controlled investment have a secondary importance. Notwithstanding, most countries endeavor to obtain what has been a characteristic of time: international credits to develop and reconstruct complementarily. Those credits must also be carefully handled because both the lender and the borrower must know their effect on their respective economies. Therefore, Nacional Financiera is authorized to negotiate everything related to international credits guaranteed by the government or by the nation. With respect to the credits many points must be studied, especially:

a) That the foreign financing be made in accordance with the domestic financing and only as a complement.

b) That the credits be directed toward productive goals, the creation of new agricultural and industrial wealth.

c) That they may not be a burden to the nation but that they be self-liquidating, studying to that effect the economic and financial standing of the borrowing enterprises.

d) That its conditions, especially the interest rate, do not become a burden for industrial development but that they facilitate it.

Nacional Financiera has obtained credits amounting to $122,000,000.00 (one hundred and twenty-two million dollars) from the Export-Import

[2]Atkins, Edwards, and Moulton, *The Regulation of the Security Markets*, p. 27 ff.

Bank of Washington, to foster transportation, oil, electricity, iron and steel, sugar production, fertilizers, meat canning, agricultural machinery, etc.

Lately a loan of $34,100,000.00 (thirty-four million, one hundred thousand dollars) was obtained from the International Bank for Reconstruction and Development to be used exclusively for electrification works. In 1948, about 30 per cent of the total resources applied to industry by Nacional Financiera were obtained through foreign credits.

VIII. The Mexican Government has prepared a national plan for agricultural production out of which irrigation and general agricultural works have been derived. The Executive Office in order to carry on this National Plan has authorized Nacional Financiera to acquire agricultural machinery for which a foreign loan of $5,000,000.00 (five million dollars) was obtained. Foreign observers may have known several United Nations data about the progress lately achieved by Mexico in agriculture.

Nacional Financiera and its basic policies grow and develop in an atmosphere backed by the Government's general economic policy, about which I shall only mention that it is followed and designed in accordance with the real economic phenomena and that it tends to increase industrial and agricultural production in order to obtain a real improvement of the economic situation and at the same time promote monetary and economic stabilization.

Consequently, our economic policy does not rest on purely monetary considerations; its views go deeper into the realistic phenomena of the economy, wherein currency is a result or a by-product.

Mexico is progressing. In the last years its national income as well as the volume of investment in industry have rapidly increased. At present the annual increase of production is calculated at 4 per cent. This increase is superior to that of the population which represents 2.5 per cent. Industrial production in the country has increased from 1939 to 1948 around 35 per cent. And according to recent studies, a slight increase in the average of human life has been noted; this also has economic causes.

The American observer will notice that the Mexico which President Truman visited is different from the one which American presidents of other times have known.

I have pointed out the basic principles of the industrial policy followed by Nacional Financiera; now it is possible to speak about results and particularly about accomplishments in the north of the country. I will only mention financial results because the treatment of particular industries will be the subject of other lectures.

During 1948 Nacional Financiera granted credits amounting to 375 million pesos (three hundred and seventy-five million pesos) and made direct or indirect investments in industrial securities totaling around 226 million pesos (two hundred and twenty-six million pesos).

Most of the financial resources were applied to the development of capital goods industries, with about 31 per cent devoted to the development of industries producing consumption goods.

According to data prepared by the Financial Research Department of Nacional Financiera, the following distribution regarding the geographical position of enterprises in 1948 can be made:

Zone	Number of Enterprises	Resources Percent
TOTAL	172	100.0
1. North of the Country	41	37.1
2. Rest of the Country	131	62.9

Therefore, Nacional Financiera's investments in the north of the country represent an important percentage, this zone having well-known agricultural, mining, and industrial activities.

In the same year, 1948, Nacional Financiera distributed around 222 million pesos (two hundred and twenty-two million pesos) in the north of the country, as following:

a) Securities held up to December, 1948	57.3%
b) Credits granted during 1948	42.7%

When I refer to the north of the country, I include the northern region and the northern Pacific zone, in order to give more complete information. That is why I consider the Territory of Baja California and the states of Sinaloa, Sonora, Chihuahua, Coahuila, Nuevo León, Tamaulipas, and San Luis Potosí, making a separate description of the Coahuila area. Nacional Financiera calculates that forty-one industrial interprises are functioning in the north of the country, their localization and resources being as follows:

Localization	Number of Enterprises	Total Resources (Thousands of Pesos)	Percent
TOTALS	41	222,274	100.0
1. Coahuila	4	92,703	41.7
2. Sinaloa	8	63,984	28.8
3. Tamaulipas	3	36,715	16.5
4. Sonora	5	7,103	3.2
5. Baja California	5	6,702	3.0
6. Chihuahua	3	6,292	2.8
7. Nuevo León	9	4,181	1.9
8. Durango	1	3,500	1.6
9. San Luis Potosí	3	1,094	0.5

Of the total resources destined by Nacional Financiera to the north of the country, 87 per cent was directed to Coahuila, Tamaulipas, and Sinaloa. This was primarily due to the development of the sugar industry and an iron and steel plant.

More than 90 per cent of the investment made by Nacional Financiera in the north was in steel, sugar, and meat-packing industries. The steel industry alone represents 76 per cent of the total resources directed towards this industry. Investments in the sugar industry in the north account for nearly 70 per cent of total investments in this field; and commitments in the meat canning and packing industries represent almost the total investment made in the country in that industry.

The financial assistance given by Nacional Financiera in the north of the country has mainly tended towards:

a) Development of enterprises such as iron and steel plants, coal mining, electric power, meat canning and packing, transportation, fertilizers, chemical and metal products.

b) Improvement of industrial techniques and increase of industrial production.

c) Increasing agricultural production through the acquisition of technical equipment.

d) Increasing the inflow of foreign exchange through the promotion of exports, helping to reach an equilibrium in the balance of international payments.

Financing is carried out through the granting of credits as well as the purchase of securities.

To undertake expenditures abroad Nacional Financiera has taken the necessary steps to obtain Eximbank credits. In this way $5,000,000.00 (five million dollars) were employed to finance the north's sugar industry. This amount was divided between Sanalona (Sinaloa) and Guayalejo (Tamaulipas). An additional $8,000,000.00 (eight million dollars) were invested to finance the steel industry—Altos Hornos de México—and $1,000,000.00 (one million dollars) to establish meat canning plants in the same region of the country.

Confining my exposition to the State of Coahuila, I shall make some general remarks in order to refer later to the most important financing Nacional Financiera has carried on there. In area, Coahuila is the third state of Mexico (150,395 square kilometers or 58,067.51 square miles). Only the states of Chihuahua and Sonora are larger. Coahuila's population has been growing, and the 1940 census figure of 3.5 inhabitants per square kilometer must be today about 5. Coahuila has been traditionally an important cattle-raising and agricultural center having besides the most important coal reserves in the country, which constitute the foundation for the development of the Mexican steel industry. From an agricultural point of view the importance of cotton, grains, and vegetable oil production is well known. During the last year production and refinement of hard fibers was intensified.

According to the 1940 census the State of Coahuila had 299,960 head of cattle or 1.99 heads per square kilometer. According to the 1947 census

the number of cattle went up to 369,750 with a density of 2.45. The number of hogs grew from 109,260 in 1940 to 127,960 in 1947. The number of sheep was 458,940 in 1947, and that of goats 1,208,320 in the same year. Accordingly, it may be said that Coahuila has the fundamental resources to develop its economy. It is immediately noticeable that Coahuila is leading a rapid movement towards the creation of factories to exploit natural and industrial resources.

To give an idea of Nacional Financiera's role in the financing of the Coahuila area, it is sufficient to say that in 1948 around 93 million pesos (ninety-three million pesos) were applied in developing this zone, representing around 17 per cent of the total volume of resources that in the same year this institution directed towards industrialization. The total financial aid is divided among stocks, mortgage bonds, and different types of credits.

Nacional Financiera has been operating in the following industrial branches: iron and steel, coal, agriculture, metal products and textiles. The financial assistance of Nacional Financiera tends to facilitate the acquisition of equipment and is sometimes given to replenish working capitals. This has been possible due to the purchase of common stocks (as temporary investments) of mortgage bonds and the granting of credits in local and foreign currencies.

The production of iron and steel was the activity that deserved greater attention from Nacional Financiera, absorbing around eighty-six million pesos in 1948, which represents 76 per cent of the total resources directed towards the steel industry in the whole country.

The development of the steel industry in Coahuila was carried out through Altos Hornos de México, S. A., a company financed by Nacional Financiera. The foreign loan obtained for this industry amounts, as I said before, to $8,000,000.00 (eight million dollars) and is guaranteed by the national government and evidenced by mortgage bonds issued by the company.

The supply of coal for the iron and steel producing enterprises has been a matter of constant interest for Nacional Financiera. For this reason the "Carbonífera Unida de Palaú" has been financed. This company exploits the coal beds in the Palaú Basin in the State of Coahuila and due to this aid has been able to develop rapidly.

Nacional Financiera has considered that electrification is an essential prerequisite for the industrialization of Mexico, using a great part of its resources in the promotion and financing of various enterprises that are dedicated to this important industrial activity. The Thermoelectric Plant near Torreón, under construction by the Federal Electricity Commission (Comisión. Federal de Electricidad) and financed through Nacional Financiera, must be mentioned.

The "Eléctrica de Monclova" is a small plant that has been financed by Nacional Financiera. It is not a power producing plant, but a company that distributes the surplus energy from Altos Hornos, supplying the

cities of Monclova and Villa Frontera in Coahuila. An investment of $9,000,000.00 (nine million pesos) is being planned to build a plant consisting of two 5,000 Kw. units with which it will expand its operations. The financing of this enterprise represents around $1,000,000.00 (one million pesos).

I want to state that in the future the importance of Nacional Financiera's financing in the Coahuila Zone will be increased because the ground is favorable. This will be a consequence of Nacional Financiera's general policy to promote in the future the industrial development required by Mexico. Using the year 1929 as a basis of 100, if the physical volume of production was 150.69 in 1945, 155.30 in 1946, 161.70 in 1947, and 162.02 in 1948, there is no reason to suppose that it will not continue increasing.

Finally, I want to express my opinion that the objectives of these lectures coincide with the greatest economic and cultural growth and prosperity of Texas and Coahuila; but as the economic progress of a state would not be effective without the flourishing of the nation to which it belongs, I hope your country and mine reach the highest development history has assigned them.

A SURVEY OF THE TEXAS CHEMICAL INDUSTRY

W. A. CUNNINGHAM

Professor of Chemical Engineering, The University of Texas

Twenty-five years ago, the chemical industry of Texas could have been described in a few minutes and with very few words. In the middle 1920's the entire industry consisted of a few plants producing lime, cement, gypsum plaster, and certain basic inorganic chemicals such as sulfuric acid, salt cake, and hydrochloric acid; most of the sulfuric acid plants were primarily operated as adjuncts to petroleum refining. In only one geographic area was there any real chemical production on a scale sufficiently large to foreshadow that which was to come. The Gulf Oil Corporation at Port Arthur operated what was, typically enough, the largest plant for the production of anhydrous aluminum chloride and the largest electrolytic chlorine and caustic soda plant in the United States at that time. These plants are still operating but on a reduced scale because the use of aluminum chloride for petroleum cracking has been superseded by other methods.

Today, the chemical industry in this area is so extensive and so varied in scope that no one person could be expected to keep up with it all. Any discussion presented today is out of date tomorrow. Although statistics are not immediately available, it is quite probable that at the present time the dollar value of chemical and related materials, such as petroleum, produced in Texas exceeds in value that of the annual production from any other state.

I. *Why is there a Texas Chemical Industry?*

A broad chemical industry doesn't follow Topsy's simple process and "just grow." The process as a whole is much more complex, but there appear to be two basic reasons behind the development of the Southwest's chemical industry. The first of these is an ample supply of raw materials, and the second is an increased demand for chemicals of all sorts.

All plants require raw materials, fuel, transportation facilities, markets, power, and labor. It is impossible to show the influence of each of these on the growth of the chemical industry of the Southwest in one brief discussion, but it is of interest to note the extent to which the fundamental raw materials of chemical manufacture are to be found in Texas. Indeed, unless raw materials and fuel are available, favorable conditions as to the other factors cannot furnish a real basis for the development of an extensive chemical industry. Hence, it is in order to discuss very briefly just what raw materials are available within the Southwest.

Petroleum and natural gas are of primary importance since they serve as both raw material for chemical manufacture and as fuel. There are in Texas alone more than 800 recognized oil fields containing approximately 105,000 wells which currently are producing oil at the rate of

nearly 2,500,000 barrels daily. Gas reserves are estimated at some 90 trillion cubic feet and have a total heating value about equal to that of the oil reserves.

Other fuel in the form of lignite and bituminous coal is estimated at from 30 to 40 billion tons. These deposits have scarcely been touched and are of value only as a future source of energy available when needed.

Of the three inorganic raw materials frequently referred to as basic to the entire chemical industry, namely, sulfur, salt, and limestone, the state has an ample supply. Indeed, the deposits of the latter two might well be described as inexhaustable.

Salt is found in unlimited quantities in the salt domes of the Gulf Coastal Plains and in the evaporite salt beds of the Permian Basin of West Texas. There are approximately 100 salt domes known which range in horizontal cross-sectional area up to 10 or 12 square miles. The depth of the salt is unknown, but seismographic surveys indicate probable thickness of at least 25,000 feet. This salt is quite pure, the major contaminant being anhydrite, which is seldom present in more than 3 or 4 per cent.

The salt occurring in the Permian Basin area of West Texas is not of salt dome character, but is a residual evaporite from inland seas or salt lakes which existed during Permian times.

Potash in various forms is found associated with the Permian Salt deposits. Though there are no potash mines now in Texas, there are to be found in the general vicinity of Carlsbad, New Mexico, three large mines which produce annually some three million tons of potash salts.

Virtually the entire United States production of sulfur is from salt domes on the Gulf in Texas and Louisiana. With the exception of two periods, one before and one just after World War II, sulfur production has been continually increasing since 1932. Production in Texas during 1948 set an all time record high of approximately 3,858,000 tons. There is little indication that either the production or use of sulfur will decline during 1949. Other sources of sulfur in the Southwest which have seen relatively little development consist of very large surface deposits of sulfur intermixed with finely divided gypsum sand and silt in West Texas in Culberson, Reeves, and Pecos counties, and in the extensive amounts of sour gas with relatively high hydrogen sulfide content which is produced from several of the gas horizons in the Southwest. There are now one or two plants which produce relatively small amounts of elemental sulfur from this source.

The third basic inorganic raw material, limestone, is available in nearly all portions of the state, except along the Gulf Coast. There, however, unlimited quantities of oyster shells found in the shallow portions of the Gulf of Mexico constitute a most reliable raw material for lime production. Much of the limestone is not of sufficient purity to warrant its use in the manufacture of high grade chemical lime.

Metallic mineral resources are not nearly so extensive as are the non-metallic minerals. Copper, silver, and mercury are being produced in small amounts, but the rather extensive iron ore deposits in East Texas far overshadow any other metallic mineral deposits. These iron ores are already being utilized by several blast furnaces now operating in the area. However, our neighboring country to the south, Mexico, is furnishing extensive supplies of vitally needed ores, such as those containing zinc, copper, antimony, and arsenic.

It is a rather anomalous situation that although the major chemical production in the Southwest at the present time involves organic chemicals, the real beginnings of the chemical industry of this area were along inorganic lines. The Southern Alkali Corporation established a plant to make soda ash, caustic soda, and chlorine at Corpus Christi in 1933. Potash, in the form of sylvinite, was discovered near Carlsbad in southeastern New Mexico in 1925, and the first commercial shipments were made by the United States Potash Corporation in 1931. Salt cake production from a dry lake south of Monahans, Ward County, started about 1935. In 1940, the Dow Chemical Company started production of magnesium metal at Freeport, and followed it shortly thereafter with the production of bromine. Incidentally, these are still the only elemental materials being produced commercially from sea water and the only plants engaged in such production are those located at Freeport.

The potential importance of the Southwest as a center of a vast organic chemical industry might have been foreshadowed by the relative ease with which the petroleum industry supplied fuel and lubricants during the high-demand period of 1914–18. At that time, however indeed, even until some ten or fifteen year ago—petroleum was looked upon primarily as a source of energy. Natural gas was merely a necessary evil which came from the well along with the oil. The only way to get rid of this excess gas was to burn it.

In the middle 1920's, organic chemists throughout the country began to turn their attention to detailed studies of the composition of petroleum and then to the possibilities of using petroleum and natural gas as a source of chemical manufacture. Petroleum oils are extremely complex in composition, and progress was slow. During the preceding quarter century or more, the major emphasis in organic chemical research and commercial production had been in the so-called aromatic hydrocarbons produced from coal-tar residue. The aliphatic or straight-chain hydrocarbons were considered to be of minor importance.

The research in aliphatic organic fields was eminently successful, and moderate commercial production of these compounds started in the early 1920's and expanded at such a rapid rate that the non-aromatic compounds exceded production of coal-tar chemicals for the first time in 1929. The trend continued, and at the present time the total weight of synthetic organic chemicals of non-coal tar origin is practically double that of coal-tar origin.

TABLE I

United States Production of Synthetic Organic Chemicals (*Chemical Engineering*, February 1947, p. 113)

Year	Coal Tar Origin (Billions of Pounds Annual Production)	Non-Coal Tar Origin (Billions of Pounds Annual Production)
1925	0.35	0.16
1930	0.41	0.60
1935	0.7	1.6
1940	1.4	4.0
1945	5.1	9.8
1946	5.2	9.2
1947	5.9	10.3

Since petroleum and natural gas constitute the only real source of aliphatic chemicals in large quantities, it was only natural that the synthetic organic chemical industry should turn to the Southwest as a site of the new industry. The movement started in the late 1930's, but reached its "floodstage" as a direct result of the war-time demands for high octane aviation fuels, synthetic rubber, toluene, magnesium, etc. So great and so rapid has been the expansion of the production of the chemical intermediates and finished chemical products from petroleum and natural gas in the Southwest that a new word "petro-chemicals" has been coined to designate this type of compounds.

Approximately $500,000,000 worth of new plants were constructed in the Southwest during the war for the production of aviation gasoline, synthetic rubber, butadiene, styrene, etc., and almost without exception these plants have been purchased and converted to the manufacture of petro-chemicals or have been continued in their original service. Tremendous expansion has also taken place since the war, as is evidenced by the fact that scarcely a month passes without an announcement of plans by some organization to manufacture more petro-chemicals. Some of these announcements of new plants deal with processes used hitherto, but others involve new processes which will make old products cheaper than the existing processes or new products for which there is an existing or potential demand.

Two new processes are the subject of a large amount of research and investigation, though neither has yet gotten into commercial production. These are the modified Fischer-Tropsch process for making oxygenated chemicals and the electric discharge process developed by Dr. E. P. Schoch of The University of Texas for making acetylene and other chemicals from natural gas. These two processes offer excellent prospects of being able to produce a large number of chemicals hitherto unavailable, for either technical or economic reasons, from petroleum sources. It has been estimated that the Fischer-Tropsch process alone will be able to produce from 50 to 100 different products in tonnage or carload quantities.

It is obvious, of course, that the rapid expansion of the petro-chemical field in itself could not long be continued without concurrent expansion in the other fields of chemical production. The high level of industrial

activity since 1940 has brought with it record production of such chemicals as sulfuric acid, soda ash, chlorine, caustic soda, fertilizer chemicals, pharmaceuticals, plastics of all kinds, both thermo-setting and thermo-plastics, synthetic fibers such as rayon, insecticides and fungicides and a host of other items demanded by this complex economy of the world. That portion of these materials which is being produced in the Southwest has shown a steady increase, though the increase is not so phenomenal as it has been in the field of petro-chemicals.

II. *Chemical Plant Locations in the Southwest*

Let us now take a look at the chemical and related industries plants which are located in the Southwest. Of course, this is a rather dangerous thing to do since the plants are so many and the new ones are going in so rapidly that it is impossible to list them all and there is even great danger of overlooking some major plant. The listings here are not intended to be complete but are presented in order to show the wide geographical distribution of such plants.

At Laredo in Southwest Texas is the plant of the Texas Mining and Smelting Company, making both antimony metal and antimony oxide. Southeast of Laredo at Brownsville, in the extreme southern tip of Texas, construction work has started on the plant of the Carthage Hydrocol Company which will make high octane gasoline, alcohols, and other oxygenated hydrocarbon products from natural gas by a special modification of Fischer-Tropsch process. Also at Brownsville, is the $12,000,000 plant of the Stanolind Oil and Gas Company being built to process the alcohols and other products of the Hydrocol plant.

The Corpus Christi-Port Lavaca-Victoria area is rapidly developing into a major chemical industry center. The necessary raw materials are present, and, contrary to existing conditions in other parts of the state, there is no immediate shortage of fresh water. As indicated by the plants listed, the industrial activities are quite varied.

At Clarkwood, a suburb of Corpus Christi, is the research laboratory of the Celanese Chemical Corporation; while at Bishop, about 30 miles from Corpus Christi, is the chemical plant of the Celanese Corporation of America at which acetic anhydride, acetic acid, formic acid, formaldehyde, and other products are being made from natural gas produced in the area. As was mentioned early in this paper, the plant of the Southern Alkali Corporation at Corpus Christi is processing locally-produced brines from Palangana Salt Dome and oyster shells from the Gulf to produce soda ash, caustic soda, and chlorine. The Corn Products Refining Company has just about completed a $20,000,000 plant for the processing of some 20,000 tons per day of milo maize into oils, starch, and other products. A very large plant of entirely different nature is to be found in the $52,000,000 plant of the American Smelting and Refining Company producing electrolytic zinc and cadmium. In addition to these major plants, there is a new cement plant and there are several small petroleum re-

fineries and natural gasoline plants in the immediate vicinity of Corpus Christi.

Farther up the Gulf Coast, just across Lavaca Bay from Port Lavaca, the Aluminum Company of America has recently acquired some 3,000 acres of land and has started construction on a reported $30,000,000 plant for the conversion of imported bauxite first into alumina and then into aluminum metal.

The announcement, some six months ago, that E. I. DuPont de Nemours Co. would locate its third large Texas plant near Victoria (the plant is now in the initial phases of construction) came as no particular surprise. Two other companies are now giving serious consideration to a location in that vicinity, and the completion of the proposed tide-water-level canal from Port Lavaca to near Victoria should attract more industries to that area.

At Boling in Wharton County the Texas Gulf Sulfur Company is operating the largest sulfur producing plant in the world. In 1948 this plant produced sulfur at the average rate of approximately 8,500 tons per day. The same company has also recently started production from a sulfur deposit in Liberty County approximately midway between Houston and Beaumont.

At Freeport are to be found the Freeport Sulfur Company and the large Dow Chemical Company plants. The Freeport Sulfur Company is at present producing sulfur from Hoskins Mound about 18 miles from the town of Freeport. The town itself was built approximately 35 years ago when this company started to produce sulfur from Bryan Mound from which dome the production of sulfur was abandoned some 10 or 15 years ago. The Dow Chemical Company has extensive operations at Freeport at which they produce a wide range of products ranging from metallic magnesium and bromine direct from sea water to styrene and many chlorinated oxygenated hydrocarbons from a plant representing an overall investment of over $100,000,000.

At Texas City, 25 miles northeast of Freeport, is to be found the plant of the Tin Smelting Corporation, the only tin smelter on the North American Continent. Here, also, are several small oil refineries, the large plant of the Pan-American Refining Corporation, and the constantly expanding operations of the Carbide and Carbon Chemical Corporation. Monsanto Chemical Company has already started production of styrene in its new plant built to replace the one which was destroyed in the disaster of about a year and a half ago. Incidentally, I would like to pay tribute to this company for the outstanding humanitarian manner in which it cared for the interests of Monsanto employees and their families after the disaster. The action of the Monsanto Chemical Company and of its officers, both as individuals and as representatives of the company, did much to dispel the illusion held in the minds of many people that large organizations are nothing but cold-hearted business machines. The

chemical industry as a whole owes much to Monsanto for the prestige which it has given to the entire industry.

The city of Houston is rightfully considered to be the center of the chemical processing industry of the Southwest. Unless one is able to spend virtually his entire time at it, it is impossible to keep up with all of the chemical industry plants which are operating and are being installed in the Greater Houston Industrial District. Among the major plants to be found either in process of erection or in operation in this area are to be found the following:

(1) The Shell Chemical Company at Deer Park—a large petro-chemical plant producing a rather wide variety of chemicals. The latest unit to go into operation was an eight million dollar plant producing synthetic glycerine.

(2) Rohm and Haas—a one and one-half million dollar plant for the production of hydrocyanic acid and its derivatives.

(3) The Gulf Chemical Corporation—a million dollar plant now under construction for the manufacture of phosphate fertilizers.

(4) Diamond Alkali Corporation—first unit of a ten million dollar plant for the production of electrolytic chlorine and caustic soda.

(5) The Nyotex Chemical Company—a three million dollar plant for the production of anhydrous hydrofluoric acid.

(6) The Sheffield Steel Company—a multi-million dollar plant operating a Bessemer open hearth process.

(7) Consolidated Chemical Industries—a large plant for the manufacture of sulfuric, hydrochloric acid, bone black, and other materials. This company has recently put into operation a new three million dollar sulfuric acid plant.

(8) The Armour Fertilizer Works—produces sulfuric acid and superphosphate fertilizers.

(9) Du Pont (Grasselli Division)—a plant for the production of freon, phenathiazine, and D.D.T.

(10) The Merichem Company—a small but rapidly growing organization, now producing a limited number of both organic and inorganic products.

(11) The Phillips Chemical Company—a subsidiary of the Phillips Petroleum Company, has recently announced a new six million dollar plant for the production of ammonium sulfate. The company has purchased the Todd Shipyard on the Houston Ship Channel and has announced that this initial ammonium sulfate plant will be the nucleus of a long-range chemical manufacturing program. The first plant will have a capacity of 266,000 tons of ammonium sulfate per year. Ammonia will be supplied from the production of the Cactus Ordnance Works at Etter, Texas, near Amarillo, which is operated by the same company.

(12) The United Salt Corporation is mining salt at Hockley Salt Dome approximately 25 miles north of Houston.

(13) The Imperial Salt Company, recently organized, has just placed in operation a salt evaporation plant on Blue Ridge Dome, a few miles outside of Houston which will produce between 100 and 150 tons per day of purified and crystallized salt for industrial and edible purposes. The salt will be mined by the brine solution process.

(14) The Champion Paper and Fiber Company has at Pasadena, near Houston, a ten million dollar plant for the production of high grade, coated magazine paper.

(15) The Mathieson Alkali Co., formerly Southern Acid & Sulfur Co., has a large plant near Houston for the production of sulfuric acid by the Lead Chamber process; most of the acid which is produced is used in the manufacture of superphosphate fertilizers.

(16) Chipman Chemical Company is one of the major manufacturers of calcium arsenate for insecticide purposes.

Major oil refineries for the production of gasoline, lubricating oils, liquified petroleum gases, and other petroleum products not normally considered petro-chemicals (exclusive of the plants at Baytown which are discussed later) are the Shell Petroleum Corporation at Deer Park; the Sinclair Oil and Refining Company and the Crown Central Petroleum Company at Pasadena; The Phillips Petroleum Company (formerly the Abercrombie and Harris Oil Company) at Old Ocean; The Continental Oil Company; The Eastern States Petroleum Company; the Warren Petroleum Company and several other small refining companies.

At Baytown, approximately 20 miles east of Houston, is the huge Humble Oil and Refining Company refinery, the largest petroleum refinery in the United States. In addition to a wide range of direct petroleum products, this company is also operating a plant for the production of toluene, as well as one of two butyl rubber polymerization plants in the United States. Also at Baytown is the co-polymer synthetic rubber plant of General Tire and Rubber Company, at which plant was developed the process for incorporating the major portion of carbon black necessary for vulcanization direct in the co-polymer as it is formed.

Some 125 miles east of Houston is to be found the huge Beaumont–Port Arthur–Orange industrial region, one of the oldest petroleum processing areas in the United States, at the same time it is the site of some of the most recent developments along petro-chemical lines. Near Beaumont, at Winnie, is the relatively new McCarthy Chemical Co. and the gasoline absorption plant belonging to the same company. The chemical plant which has recently been placed into operation represents an investment of more than ten million dollars and will make a line of organic chemicals such as methanol, formaldehyde, and acetic acid from natural gas. In connection with its operations, this company is operating the largest oxygen plant in the United States.

Major petroleum refineries in the area include the huge plants of the Gulf Oil Company, the Texas Company, the Pure Oil Company, the

Atlantic Refining Company, and the Magnolia Petroleum Corporation—all of which are constantly expanding. At Nederlands, about midway between Beaumont and Port Arthur, is located the relatively old asphalt plant of the Texas Company, as well as some of the newest petro-chemical plants. These latter include the fifty million dollar butadiene plant of the Neches Butane Products Corporation and the closely associated co-polymer or Buna-S rubber plants of the B. F. Goodrich Chemical Company and the Firestone Chemical Company in which butadiene and styrene are co-polymerized to produce synthetic rubber. The newest of the petro-chemical plants in this area is that of the Jefferson Chemical Company, a subsidiary of the American Cyanamid Company and the Texas Company, which is now producing ethylene oxide and ethylene glycol from its new twenty million dollar plant. This is reported to be the first part of an anticipated large plant for the production of numerous chemicals from refinery gases to be obtained from the surrounding refineries. Midway between Port Arthur and Orange is Du Pont's new plant for the production of nylon salts. Current reports indicate that within a relatively short time the investment of this company in plants in the Port Arthur–Orange area will be second only to the huge operations of the company at Wilmington, Delaware. The Orange Pulp and Paper Company located at Orange makes craft paper and special wrapping papers.

The chemical and related products plants of East Texas are not confined to the Gulf Coast region. At Lufkin is located the plant of the Southland Paper Mills for the production of newsprint which was built before the war and has been expanded twice since its initial construction. The East Texas iron ores are being utilized as raw material in the blast furnace operations of two plants, namely the thirty million dollar plant of the Lone Star Steel Company at Daingerfield and the newly constructed plant of the Valencia Iron and Chemical Company at Rusk. Farther north is the salt mining operation of the Morton Salt Company near Grand Saline, Texas, at which salt is being produced from one of the farthest-inland salt domes known.

In Louisiana most of the chemical processing plants are located west of the Mississippi River. Lake Charles is developing very rapidly into a petroleum refining and chemical manufacturing center. The Tutwiler Plant of The Cities Service Refining Corporation has been materially expanded; within the past year announcement has been made of the forthcoming construction of a thirty million dollar lubricating oil plant by the Citcon Corporation. The Mathiesen Alkali Corporation, the producer of soda ash, caustic soda, and chlorine, has recently doubled the size of its former plant by spending some four and a half or five million dollars for a new processing equipment. The Southern Alkali Corporation bought the magnesium plant at Lake Charles, formerly government owned, and has converted it into a very efficient alkali and chlorine producing unit. Cities Service also operates a butadiene plant, and the Firestone Rubber Company has a co-polymer plant here.

The operations and plants of Myles Salt Company and of the Bay Chemical Company, both in Iberia Parish, Louisiana, have recently been purchased by the Morton Salt Company. The Bay Chemical Company has been manufacturing hydrochloric acid and salt cake, and the acquisition of these two companies by the Morton Salt Company apparently is the initial step this organization has taken to get into the manufacture of inorganic chemicals, primarily those of sodium base. Commericial Solvents Corporation has a large plant at Monroe for making methanol, ammonia, and carbon black as well as a relatively small petro-solvent plant located at Sterlington, Louisiana. The main plant of the Columbian Carbon Company for the production of carbon black is also located at Monroe, Louisiana.

Baton Rouge is a large petroleum processing center. Here are to be found the Ethyl Corporation Plant to which has recently been added a twenty million dollar expansion, the complete petroleum refinery of the Jersey Standard Company, as well as the seven and a half million dollar plant of the Co-polymer Corporation which was built during the war and which has been converted to low-temperature polymerization.

Though they are neither so numerous nor so large, plants in Arkansas, Oklahoma, New Mexico, and North and West Texas contribute materially to the chemical processing operations of the Southwest. The Helena Cotton Oil Company at Helena, Arkansas, has recently put into operation a three hundred thousand dollar extraction plant for the removal of oil from cottonseed. This is the first major commercial operation utilizing such a process. The Lion Chemical Company at Eldorado, Arkansas, has purchased and is expanding the ammonia and ammonium nitrate fertilizer plant which it operated for the government during the war. This same company is also operating a petro-chemical plant for the production of solvents. In Tulsa, the Oklahoma Chemical Company has recently placed in operation a new half-million dollar plant for the manufacture of super-phosphate fertilizers. The home office and major refinery of the Phillips Petroleum Corporation is located at Bartlesville. Other major petroleum refineries in Oklahoma are the Stanolind Oil and Gas Company at Tulsa and the Continental Oil Company at Ponca City. Farther north in Hugoton, Kansas, the Stanolind Oil and Gas Company started construction some time ago on the huge eighty million dollar Fischer-Tropsch gas conversion plant for the production of numerous oxygenated solvents. However, it was recently announced that the construction of this plant had been stopped and the entire construction program had been postponed because of mounting construction costs.

In southeastern New Mexico, near Carlsbad, are three plants which are mining the refining potash salts from the Permian salt deposits of that area. Two of these plants, the United States Potash Corporation and the Potash Company of America, produce muriate of potash only, while the third, the International Minerals and Chemicals Corporation, produces both muriate and sulfate of potash. All three of these plants

have recently undertaken expansions, and at least one company is giving serious consideration to entering into the manufacture of a rather extensive line of potassium chemicals.

Coming back into Texas, east of Carlsbad and near the Texas–New Mexico border, we find the heavy chemicals plant of the Frontier Chemical Company producing sulfuric acid, caustic soda, and chlorine. Capacity of this plant is now being doubled by a very ambitious expansion program. Numerous carbon black plants are located throughout West Texas and particularly in the Panhandle region in the general vicinity of Amarillo. The ammonia plant of the Phillips Chemical Co., referred to earlier in this paper, as well as the co-polymer plant operated by the United States Rubber Company at which the recently announced low-temperature co-polymerization process for the production of a superior grade of synthetic rubber is being utilized, are near Amarillo.

Although the Dallas-Fort Worth area is not so highly industrialized from the chemical process standpoint, as are the areas along the Gulf Coast, chemical plants are not entirely lacking in the area. The Procter and Gamble Company has a plant at Dallas for the production of soaps, edible oils, and synthetic detergents. Cement, sulfuric acid, synthetic catalysts for petroleum conversion, and several other chemicals are being produced by numerous plants on a relatively small scale.

Impressive as the foregoing list of chemical processing plants appears, it certainly is not complete. Numerous plants, some of them perhaps very large, have not been included in the list. The most impressive aspect is the extent to which the petro-chemical industry has been expanding in the past decade. The presence of natural gas for both fuel and raw material for chemical production has been essential, but deep water transportation and an abundance of other basic raw materials has been highly influential in causing manufacturers to locate in the Southwest.

The petroleum industry itself is primarily a producer and marketer of energy in the form of liquid fuels, in other words, large volume, low-profit-margin products. One factor of mutual advantage to be enjoyed by chemical manufacturers and large petroleum refineries is the fact that there can be a profitable exchange between the two groups, the refiners furnishing a wide range of hydrocarbons to the chemical plants for processing and the chemical manufacturers in turn selling large quantities of chemicals which do not compete with the basic products of petroleum refineries. The complementary nature of these operations is due for even greater emphasis within the next few years.

Some idea of the size of the combination oil and petro-chemical industry can be gained by the fact that today it is capable of supplying annually about 85,000,000 pounds of benzene, toluene, and xylene alone, as well as the entire prewar requirements of ethyl alcohol. During the war the petroleum industry supplied 1,000,000,000 pounds of butadiene per year and about the same amount of cumene (isopropyl benzene) for aviation fuel. These full capabilities are not being utilized at the present

time, although the industry is now supplying 5 per cent of the methanol, 50 per cent of ethanol, 100 per cent of the isopropyl alcohol, 75 per cent of the acetone, 35 per cent of the normal butyl alcohol, 90 per cent of the amyl alcohol, a major portion of the xylene and increasing amounts of acetic anhydride, acetic acid, glycerine, cresylic acids, toluol, and much of the synthetic detergents. Despite this apparently tremendous production, it has been estimated that the entire range of commercial chemicals and synthetic products which might be made from petroleum could utilize less than 1% of the world's crude oil supply.

Mr. H. W. Fisher, president of "Enjay," the new petro-chemical subsidiary of the Standard Oil Company of New Jersey, recently stated in *Chemical Engineering:*

Without doubt, future possibilities are tremendous and by continuing the sympathetic and co-operative spirit which has marked past relations between the two industries (petro-chemical manufacturing—petroleum refining) the future development can redound to the benefit of both. We do not think of the chemical activities of the petroleum industry as being in conflict with those of the chemical manufacturer but rather as a relationship between the raw material supplier and the consumer.

III. *What Is To Come?*

The foregoing list of chemical industries in the Southwest is, of course, tremendously impressive, but the same impressive extent of the industry and the rate at which it is using up the raw material reserves gives particular concern for the future of the industry. Although the estimated reserves of natural gas in Texas have increased during the past several years, the depletion or use of these reserves has increased at a more rapid rate. This is indicated by the data presented by Dr. E. P. Schoch of The University of Texas before the annual meeting of the Chemical Engineering Section of the American Society for Engineering Education in Austin, June, 1948. The figures quoted by Dr. Schoch are based on data obtained from the Texas Railroad Commission.

TABLE II

Some Texas Statistics of Natural Gas Production

Item	Trillion Cubic Feet 1944	1948*	Ratio 48/44
1. Total Gas Produced and Used	1.9	2.7	1.42
2. Pipe Line Gas Used in Texas	0.54	0.75	1.39
3. Pine Line Gas Exported	0.34	0.82	2.41
4. Fuel Gas for Drilling, etc.	0.17	0.29	1.70
5. Gas for Carbon Black	0.6	0.4	0.67
6. Gas Wasted and Lost in Operations	0.25	0.46	1.84
7. Estimated Gas Reserves	75	86	1.15
8. Life of Gas Age: Item 7 divided by Item 1	40 yrs.	32 yrs.	0.8

*The figures for 1948 are those for March, 1948, multiplied by 12.

The foregoing table shows that the estimated life of the chemical gas age in the Southwest is decreasing because the annual withdrawal

of gas is increasing more rapidly than the gas reserves. There are two ways in which the gas age can be lengthened: first, by increasing the efficiency with which the gas and petroleum are being produced, and second, by decreasing the annual gas consumption through more efficient processing.

In recent months there has been some decrease in general industrial activity. Though the chemical industry has not been any exception, the Gulf Coast has experienced a much smaller decline than has the other chemical industry sections of the country. The following note from *Chemical and Engineering News,* May 23, 1949, illustrates rather clearly the fact that Texas is now the bright spot in the darkening, but definitely not gloomy, chemical industry picture.

Indications of a general leveling-off trend in the chemical industry are found in the considerable increase in numbers of chemists and chemical engineers from other areas seeking employment in the Gulf Coast Section. Four or five times the usual number of such job-seekers for this time of year have been dropping by our Houston editorial offices for employment advice, only to find that the same trend exists in the Gulf Coast. There are no indications of recession, however, and in the Gulf Coast at least this leveling-off is not expected. Construction has slowed down, with the Aluminum Co. plant at Point Comfort, Texas, the only large one currently building, but several others are planned for the near future. Interestingly enough, a contributing factor in the job situation is the fact that some companies have not been able to finish their laboratory and office buildings and, while they may have openings, simply do not have space for new men.

Two other factors also may have material effect on the future growth and expansion of the Texas chemical industry. As has been pointed out, the availability of raw materials, particularly petroleum and natural gas, has been of major importance in the development program of the past two years. The bulk of the chemicals being made in the area are intermediate products and are shipped to the eastern part of the country for conversion to finished products—many of which are reshipped to the Southwest trade area. There is need for development of facilities in this area which would utilize the intermediate products locally in the manufacture of finished goods which could be distributed to markets all over the world. This phase of the development is currently handicapped by the freight rate structure of the nation which, at present, favors the shipment of raw and partially processed materials to the so-called "Official Zone" north of the Ohio River and east of Chicago and the shipment of finished products from that zone to the Southwest. For example, it costs from 25 per cent to 100 per cent more to ship a carload of finished products from Texas to New York than it does to ship the same carload of products from New York to Texas.

The other factor is the fact that with the rapid expansion of the pipeline transportation of natural gas out of the state, it may become more economical to process the gas at the discharge end of the pipeline first into intermediates and then into finished products for shipment back to Texas.

Most of the chemical manufacturing plants of the state have been financed by out-of-state money. It is unfortunate that this is so, but the economic structure of the state has been so firmly based on those products which either grow in the field, come from a well, or have hide, hair and horns that Texas–venture capital has been extremely cautious about entering the relatively unknown field of chemical manufacture. The situation is changing rather rapidly, however, and many of the industries which are now being started or which will be started in the future will be financed locally.

From the standpoint of the national economy nothing is gained by the simple transfer of some industrial activity from one location to another. Net gain can come only when a new industry is created, based on the production of some material hitherto unavailable because of inadequate supply or at an uneconomically high price. It is the function of research to develop these new processes whereby the wealth of the nation can be expanded.

The extent to which research studies are being carried out in the various laboratories is encouraging and bodes well for the future well-being of the Texas chemical industry. Since there is no line of demarcation between pure or fundamental research and applied research but a distinction between these and research seeking to improve process and operation efficiencies, the former is developing rapidly in the educational institutions of the state and in private or industry-owned research laboratories which are geographically separated from the manufacturing operations of the parent company. It is encouraging to note that there is a decided trend toward the establishment of such laboratories in this part of the country. Among such laboratories are the following:

1. Shell Oil Company at Houston.
2. Humble Oil and Refining Company at Baytown.
3. Jefferson Chemical Company at Austin.
4. Atlantic Refining Company, Production Research Laboratory, Dallas.
5. Magnolia Petroleum Company, Field Research Laboratory, Dallas.
6. Texas Research Foundation at Dallas.
7. Southwest Research Institute at San Antonio and Houston.

Of the educational institutions which are conducting research programs, Rice Institute, Texas Agricultural and Mechanical College, and The University of Texas are most prominent. The latter school has recently acquired the properties of the Austin Magnesium Plant operated during the war by the International Minerals Chemical Corporation at which a broad research program of major importance to the state can be developed if adequate support can be given to it.

Practically all organizations engaged in or concerned with the petrochemical field are carrying on research projects which bid fair to continue the progressive activities which have characterized the past ten

years. Undoubtedly, one of the major objectives of these research activities will be to develop methods for using more profitably and more economically the methane content of the natural gas. Most of the petrochemicals now made come from the higher hydrocarbons such as ethane, propane, etc., and most of the methane is now being used as fuel, with decreasing amounts being wasted to the atmosphere or burned in flares; the latter is being discouraged by very vigorous action on the part of the Texas Railroad Commission. The immediate future of the Texas chemical industry is extremely bright, but the continuation of this tremendous industry appears to be dependent to a large extent on the development of better methods for the utilization of that constituent of natural gases which occurs in greatest quantity, namely methane; and in the development of ways and means for bringing to the surface a greater proportion of the petroleum and gas which occurs in the underground reservoirs. Without these the age of the chemical industries in Texas is very definitely limited.

SOME PROBLEMS OF RELOCATION FACING THE STEEL INDUSTRY

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The Framework of the Location Problem

The location of a plant to produce iron and steel rests upon a three-legged stool: the source of iron ore, the source of coking coal, and the lacation of the market for iron and steel. In this respect, the problem of locating an iron and steel plant is quite different from that of locating an industrial establishment of some other kind. In the iron and steel industry, the costs of transportation of raw materials and of finished products are so great relative to total costs as almost to dominate the selection of a producing site. Of course, it is true that other considerations have a bearing. An iron and steel company cust consider the availability of skilled labor, costs of electric power, and local taxes in the same sense that the executives in another industry would do so. And, it is likewise true that transportation facilities and costs bear in some degree upon the location of any sort of factory. But, in iron and steel, transportation of the major raw materials and of the finished product is so important that a site well located with respect to coal, ore, and markets will usually be the right location even though other cost factors may argue moderately against that location.

Let me illustrate with some figures the importance of transportation costs of raw materials. In 1948 the price of Mesabi Non-Bessemer ore at the Minnesota mines was reported at $3.77. But transportation and handling from the mines to a producing center on the shore of Lake Erie added $2.43 to this price, so that the price at the Lake Erie blast furnace was not $3.77, but $6.20.[1] Thus, in spite of the low cost of the Great Lakes route over which this ore was moved, transportation expanded the cost by nearly 65 per cent. Turning to transportation of coal, the value of coke at the ovens in Pittsburgh in 1945 was reported at $6.02, of which, because of Pittsburgh's location in the coal fields, only some 30c represented transportation cost. By contrast, the value reported for Cleveland and Detroit was $8.32,[2] an increase of 38 per cent representing the cost of moving the coking coal overland from the Pittsburgh producing regions to the Great Lakes, a distance of 130 to 250 miles. In 1937 it was reported that the total costs of assembling the raw materials per ton of pig iron at a number of northern producing centers varied from $6.31

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[1]Wade, Henry H., *Mining Directory of Minnesota*, Mine Experiment Station, University of Minnesota, Vol. LI, No. 21, May 1, 1948, page 236.

[2]Voskuil, Walter H., "Coke—A Key Industrial Material," *Journal of Land and Public Utility Economics*, November, 1946, page 343.

at Weirton and Stubenville to $7.59 at Chicago.[3] These figures included the cost of transporting limestone at $0.337 for Weirton-Stuebenville and $0.241 at Chicago. The remainder was transportation cost of ore and coking coal. Inasmuch as the price of pig iron in the Ohio Valley and at Chicago at that time was in the neighborhood of $23.00,[4] the reported transportation costs of $6.31 and $7.59 are well over 25 per cent of this value. An iron and steel plant must be located either with one or both of its major materials close at hand or, if at a distance, on a low-cost transportation route. At greater distances, water transportation is almost imperative. I shall not take the time here to relate these generalizations to such locations as Pittsburgh, Chicago, Birmingham, and Baltimore, but an examination of the raw material sources for each of these iron and steel centers will bear out the importance of low cost access to ore and coal.

With regard to the third leg of the stool, proximity to the market, a location which is ideal with respect to coking coal and iron ore might still prove unsuitable if too far from large centers of steel consumption or if low-cost transportation routes to such centers were lacking. Of course, we must not overemphasize access to the market because to some extent steel production attracts markets to it. This is true in the sense that steel-consuming manufacturers such as automobile parts, freight car construction, and other metal working and fabrication industries try to locate resonably close to where their steel is made. But, in the last analysis, steel fabricators have to think not so much of their steel supply as of their own customers and so must have low-cost access to a large and prosperous population who can buy and use their products. Farm implements have to be made not too far from prosperous regions of mechanized farming, freight cars near centers of high trackage density, and automobiles where a price "f. o. b. Detroit" will be lowest for the largest population of car buyers. Thus, while steel production pulls the steel-using industries towards it, the markets for the products of these steel-using industries pull in the opposite direction, and, if steel production is too far from the ultimate markets for machines and for steel structures, the steel-producing center will lose this tug of war and find itself too remote from its direct customers. In the spring of 1947 when the price of steel bars at Pittsburgh was reported at $2.60 per 100 pounds, freight on this item from Pittsburgh to Los Angeles was reported at $1.015, a figure so nearly prohibitive that little steel was being shipped between these points. By contrast, Sparrows Point, Maryland, with deep water transportation to Los Angeles could and did ship to the latter destination at only $0.625 per 100 pounds. The Sparrows Point location,

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[3]Worthing, Marion, "Comparative Assembly Costs in the Manufacture of Pig Iron," *Pittsburgh Business Review*, University of Pittsburgh, Vol. VIII, No. 1, January 31, 1938, page 22.

[4]American Iron and Steel Institute, *Annual Statistical Report for 1947*, page 162.

near Baltimore, was obviously justified in part by its access to the growing Pacific Coast market. Of course, the advantage of Sparrows Point with respect to Los Angeles was somewhat offset by the long delivery time, representing an inventory problem to the California consumer. But the low-cost relationship of the steel-producing location to the steel-using industry is clearly of great importance.

During the decades since World War I, access to market has come to have a double meaning to steel industry. One of its major raw materials has come to be purchased scrap iron and steel, and the steel-consuming region is a fertile source of this scrap. Thus, there is a two-way flow of traffic between the iron and steel industry and its market—finished steels moving from the steel mill to the market and scrap moving in the opposite direction. In 1947, a typical recent year in this respect, the foundry and steel-making industries consumed one-half as much scrap iron as they did pig iron.[5] Thus, the steel industry has come to be in substantial measure a converting industry, transforming old and discarded steel into new, as well as a basic-producing industry. The importance within a locality of the ratio of scrap producing (*i.e.* steel-consuming) industries to steel production in that locality is apparent in the following prices of No. 1 Heavy Melting Scrap in May, 1949:[6]

Pittsburgh	$22.50 to $23.00
Detroit	16.50 to 17.00
Boston	14.25 to 14.50

So proximity to market means not only low cost on transportation of product steels but also low cost for an important steel material, scrap.

The economics of iron and steel location have altered somewhat in recent years and may be subject to further change in the years ahead. But the theme of access to markets and to raw materials runs through these changes quite persistently. I shall proceed with a review of some of the new factors in the picture and the way in which each seems to bear on the locational outlook for iron and steel production. In doing so, it will be important to bear in mind this frame of reference of access to materials and markets so dominant in the locational question.

The locational problems facing the iron and steel industry during the 1950's will arise largely from the two following factors:

1. The forthcoming decline in the producing capacity of the Lake Superior ore mines.
2. The institution of f. o. b. mill pricing.

While these two are the dominant new influences, their bearing upon the question must be considered in the light of still other changes. Included among the latter are:

1. The growth of steel markets in the South and the West.

[5] *Yearbook*, Institute of Scrap Iron and Steel, Washington, 1948, page 13.
[6] *Iron Age*, Vol. 163, No. 21, May 26, 1949, page 162.

2. Changing technologies of iron and steel production.
3. The growth of highway and water transportation relative to railway movement of steel.

The Outlook for Iron Ore

The forthcoming decline in the producing capacity of the Lake Superior ore mines points towards new blast furnace construction at such places as Birmingham and along the coasts, Atlantic, Gulf, and Pacific. The promise of a particular coastal location is conditioned by its proximity to large and reasonably diversified markets and by its access to coking coal. Because of the paucity of fundamental research on the question of iron and steel locations in recent years, present conclusions must be tentative. But the nature of some of the factors at work can be outlined.

The iron and steel producing region now dependent primarily upon the ores of the Lake Superior District represents over 75 per cent of all the iron and steel capacity in North America. It includes the locations which might be generally designated as falling within the Great Lakes region, Pittsburgh, Buffalo, Youngstown, Wheeling, Cleveland, Lorain, Detroit, Gary, Chicago, and similarly located points, situated upon or sufficiently close to a lake port to receive ore economically by water from the western shores of Lake Superior. Therefore, any material alteration in the outlook for these ores bears upon the location of most of the present steel-producing capacity of the country.

The percentage of Lake Superior ores to total ore production of the United States for selected years has been as follows:

1927	83.5
1929	86.0
1933	83.5
1939	80.5
1942	86.3
1948	82.0[7]

These percentages indicate not only the relative magnitude of the district, but also the maintenance of this magnitude in the total picture of ore production throughout the country.

In 1947, about 76 per cent of all the ore shipped from the Lake Superior District (United States and Canadian) was produced by the open pit mines of Minnesota.[8] If this rate of extraction were to be continued the direct-shipping, open pit ores would be exhausted in about 14 to 16 years. This calculation takes into account inferred reserves as well as those declared and subject to taxation. Of course, underground reserves would remain, and if their output could be expanded to replace the open pit ores, the total life of present commercial reserves in these ranges could be increased to probably 25 years at the 1947 rate of extraction.

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[7] *Metal Statistics, 1949*, American Metal Market, New York, 1949, page 31.

[8] Estimate derived from the *Annual Report, 1947*, Lake Carriers Association, Cleveland, 1948, page 66.

But, the additional productive period which would be made possible by extension of the underground workings would be too short to warrant the great capital investment and the recruitment and training of labor. Therefore, calculations must assume that the underground ores will not replace substantially the open pit reserves, and we are back to our 14- to 16-year estimate. The picture is relieved somewhat in 1949 by the prospect of declining iron and steel production. For example, if a depression beginning in 1949 were to reduce open pit ore consumption through the coming two decades to an average of 60 per cent of the 1947 rate, the outlook would be for a life of 22 years instead of 14. Thus, a business recession will give the industry more time to make adjustments. On the other hand, the picture is made worse by the circumstance that as the open pit mines approach exhaustion, their productivity declines. For example, the Hull-Rust-Sellers group shipped nearly 20 million tons in 1945, but in 1946 its output had declined to 13.5 million and in 1947 to 10.3 million tons. Therefore, we may reasonably expect the annual capacity of the open pit mines to go down even when their ultimate exhaustion is still some years away. On balance, it would appear that, while the Lake Superior District will probably continue to produce from present commercial reserves for something like half a century, its peak annual capacity will begin to decline seriously during the 1960's.

To complicate the picture, about 60 per cent of the remaining reserves in the Lake Superior District are controlled by two ore-consuming interests, the United States Steel Corporation and the National Steel Corporation (the latter through the M. A. Hanna Company). These two interests represent about 45 per cent of the blast furnace capacity of the Great Lakes region. This circumstance indicates that the remaining 55 per cent of the blast furnace capacity controls only 40 per cent of the ores and is going to feel the shortage at a somewhat earlier date.

The Future of Beneficiation

In this picture of ore depletion it is not to be implied that disaster is impending for the steel industry of the Great Lakes region. In northern Minnesota there remain reserves of iron-bearing rocks, loosely termed "taconite," sufficient to supply the iron industry for many generations at full capacity. This taconite can be beneficiated by methods now known, in the laboratory sense, and it is today processed by pilot plants.

But, although the change will not mean disaster, it will mean growing disadvantage to the Great Lakes region, primarily because of the large investment which will be required to beneficiate the taconite. The composition of this mineral is such that its concentration will require an investment in beneficiation plants in northern Minnesota of about $10 to $15 per ton of annual ore capacity. Thus, the total investment necessary to replace the present open-pit production would be not less than $500 million, making full allowance for the higher iron content of the new concentrate. This investment is discouraged by technological uncertainty, by the low price of ore, and by the irregular market for ore.

As regards technological uncertainty, methods of beneficiation of taconite are still under development so that extensive change will probably continue over a number of years. Thus, the first full scale plants, representing a minimum investment in the neighborhood of $25 million each and having an annual capacity of about 2.5 million tons of concentrate, will be subject to rapid obsolescence.

Furthermore, the present and prospective prices of ore do not appear to warrant this large an investment. The price of Lake Superior ores has not gone up adequately to reflect the rate of depletion. This is probably because most of the remaining reserves and most of the annual production of ore are for use rather than for sale. That is, in large measure, iron producing companies mine the ore for their own consumption. These companies have little to gain by letting the price of ore go up because they do not sell much of it. On the other hand, they have much to lose. Ad valorem taxes, especially in Minnesota, on declared reserves and on annual production would be increased were the price of ore to rise sufficiently to reflect the impending shortage. In addition, royalty payments would be increased. Under these influences, the prices of ore have not been allowed to rise to the point where independent interests would find it inviting to establish beneficiation plants for merchantable concentrate.

Ore production is notably a "feast and famine" activity. Iron and steel production, of course, are highly sensitive to depression.[9] To make matters worse, during depression the steel industry relies more on scrap iron and less on new iron produced from ore, so that the reduced demand for steel is accentuated in its effect on ore shipments. While ingot production declined by 44.5 per cent between 1937 and 1938,[10] ore shipments declined by 69 per cent.[11] Thus, the prospective ore beneficiation industry will be notably sensitive to depression.

These three factors, rapid obsolescence of plant, low price of ore, and high variability of demand will probably keep the prospective beneficiation industry from developing enough to replace fully the present open pit reserves as the latter run out. The first commercial scale plant was announced in 1947 to be built and operated by the Reserve Mining Company at Beaver Bay, Minnesota. At that time there was reason to expect that concentrates might be shipped from this plant by 1953 or 1954. But, as of May, 1949, construction has not yet begun, and with the current outlook for a declining ore market there is reason to infer that the investment interests behind this venture find it too discouraging for early action. With this initial experience as an indicator, it appears highly probable that the new beneficiation industry will be developed somewhat tardily and that, while it will eventually become adequate to accommodate

[9]The U.S. Department of Commerce classifies the iron and steel industry in Group V, the most highly sensitive to business fluctuations. See Denison, Edward F., "Industrial Composition of National Income," *Survey of Current Business*, December, 1948, page 5.

[10]*Annual Report, 1947*, American Iron and Steel Institute, New York, 1948, page 34.

[11]*Metal Statistics, 1948*, American Metal Market, New York, 1948, page 35.

average demand for Lake Superior ores in the Great Lakes steel producing regions, it will never be built big enough to take care of peak demands.

From this general sketch it seems reasonable to expect that beginning in the 1960's the iron and steel industry of the Great Lakes region will have to draw on imported ores during periods of large scale production of iron and steel. Apart from the ores in the Adirondack Mountains, the Great Lakes region will not have access to any large quantity of deposits in the United States outside of the Lake Superior District. The foreign sources which now appear most promising from the standpoint of quality and possible quantity are Labrador, Venezuela, and possibly Brazil. The ores of Chile are, for the most part, reserved to the new Chilean iron and steel industry and to the American coastal plants of the Bethlehem Steel Corporation. Cuba and Newfoundland contain large deposits of ores, but most of it is of a consistency and composition unsuited to present American blast furnace construction and practice. Liberia and Sweden may be expected to furnish high grade ores, but for the American Great Lakes steel industry, in relatively small quantities.

Competition with Coastal Locations for Imported Ores

Transportation of imported ores to the Great Lakes region would represent a competitive disadvantage to iron and steel production in this area. Possible routes which would minimize overland movement would be: (1) rail shipment from Chesapeake Bay to Pittsburgh; (2) barge shipment from New York via the Hudson River and the New York State Barge Canal; and (3) movement by ore carrier up the St. Lawrence River, from Seven Islands or Montreal, particularly if the proposed St. Lawrence Seaway is completed. Considering the most promising of these routes the proposed St. Lawrence seaway, one analysis estimates that "delivered costs on South American ore at Lake Erie ports, exclusive of tolls charged for use of the Seaway, would be from $1.15 to $1.50 higher than delivered costs at Atlantic ports, such as Baltimore."[12] Taking the lower of these two figures, a disadvantage of $1.15 per long ton, this represents a penalty of about $1.58 per net ton of pig iron or $1.31 per net ton of finished steel.[13] This handicap of $1.31 represents 2 per cent of

[12]Zeis, Paul M., Beitscher, Henry, and Smith, Robert, "An Economic Appraisal of the St. Lawrence Seaway Project," the *Industry Report on Domestic Transportation* of the Bureau of Foreign and Domestic Commerce, August–November, 1947.

[13]To relate $1.15 to the iron content of imported ore, a content of 65 per cent was assumed:

$1.15 x 100/65 = $1.77.

To convert to net tons:

$1.77 x 2,000/2,240 = $1.58. This figure falls short of accuracy in its disregard of pig iron yield ratio.

To convert to finished steel competitive handicap:

Pig iron charged to steel making furnaces, 1947, 52.2 million tons. Finished steel shipped, 1947, 63.0 million tons.

$1.58 x 52.2/63.0 = $1.31.

Data derived from *Annual Statistical Report*, American Iron and Steel Institute, 1947, pages 16 and 57.

the *Iron Age* composite price of finished steel as of December 31, 1947.[14] Inasmuch as profit on sales for the industry as a whole that year approximated 6.3 per cent,[15] the penalty of 2 per cent to the Great Lakes region indicates the relative general magnitude of the competitive disadvantage in the kind of active year in which imported ores would be drawn upon in large volume. Inasmuch as these data are averages and include some broad estimates, they are intended merely as indicators of the future motive to relocation and should not be construed as reliable estimates for any particular operation on a given future date. But a penalty which in prosperous times, might generally amount to about one-third of profit would prove rather severe. It must be borne in mind that large tonnages of steel now produced in the Great Lakes region are shipped to coastal areas such as the Middle Atlantic States and the Gulf South. That portion of the Great Lakes industry shipping steel to coastal areas would hardly be econmically justified if it had to import ore from a seaport in competition with a coastal iron and steel location.

The outlook for relief from the St. Lawrence Seaway is further modified by the limited ore-carrying capacity of the proposed route. Under the lock capacity contemplated in one plan and allowing for heavy traffic in other commodities than ore, probably not more than 30 million to 37.5 million tons of iron ore could be moved through the Seaway in a season.[16]

With respect to the newly-developed ores of Labrador, while the Seaway route would probably be little, if any, higher in cost than the present route from Duluth to Lake Erie, the St. Lawrence route would be in competition with the sea lanes to Baltimore and other coastal locations as well as to Great Britain. Ore could be moved from Seven Islands in the mouth of the St. Lawrence to Baltimore in larger, more economical vessels, in a year-round movement over an ice-free waterway, without delay by locks, free of seaway toll charges, and without the necessity of moving upstream against a river current while fully loaded. For all these reasons, Labrador is of greater promise to coastal steel blast furnaces than it is to those of the Great Lakes. The comparison with the present Great Lakes route is invalid because no other blast furnace location but the Great Lakes industry now has access to the Lake Superior ores, and this will not be true of the Labrador ores.

With regard to competition from Great Britain, trans-oceanic movement from Labrador to England would be little, if any, more costly than the present movement of ore from Chile to Sparrows Point, Maryland, a workable route. Furthermore, economic and sentimental ties between Canada and Great Britain would give the latter a competitive advantage over the Great Lakes steel industry in purchasing from Quebec. While the part played by the M. A. Hanna Company of Cleveland in the development of the Labrador ores offsets this disadvantage in some measure, we

[14] *Iron Age*, Vol. 161, No. 1, January 1, 1948, page 268.

[15] *Annual Statistical Report*, American Iron and Steel Institute, 1947, page 9.

[16] Zeis, Paul M., et al., *op. cit.*

should be making a great mistake if we regarded the Labrador ores as being the exclusive preserve of the Great Lakes steel industry. Rather, it appears that the Great Lakes region may merely share in limited measure in these deposits.

Finally, with respect to the capacity of Labrador, the reserves now proven promise annual shipment of 10 million tons, a huge amount, but small in relation to the coming needs of the Great Lakes industry, the coastal industry, and Great Britain. There is some hope, of course, not too visionary, that Labrador may eventually prove as vast as the Mesabi once was. But, this is conjectural.

The iron and steel industry of the Great Lakes region, therefore, will have to compete at some disadvantage with coastal locations for imported ores. With respect to steel production for coastal markets, this disadvantage will probably lead to construction of new plants at seaports well located with respect to coking coals in the interior. Promising seaports include Baltimore, Mobile, and Houston. Boston, Massachusetts, has sometimes been erroneously mentioned as a good future location for blast furnaces. This is probably because of its proximity to Labrador and because it is the American port closest to some Latin-American ores, notably those of Brazil. But Boston is too much on the periphery of the southern New England and Middle Atlantic steel markets. Moreover, Boston is too far from good coking coal, probably a fatal disadvantage. By contrast, such cities as Baltimore, Norfolk, and Newport News have comparatively short routes to the western Pennsylvania and West Virginia and Kentucky coal fields, served by well developed coal-carrying railroad systems, and Baltimore is more centrally located with respect to the market. Mobile might obtain coking coal from the Birmingham district and Houston from its present sources in Oklahoma. This is not necessarily to advocate any of these cities as locations for new blast furnaces, particularly at the present time, but merely to point out that their competitive position relative to the Great Lakes region will improve with the exhaustion of open pit ores of Minnesota and that they merit careful study.

The Role of Coking Coal

Promoters of particular seaport cities should be cautioned with respect to the need for coking coal. In many instances coal which is well suited for most fuel requirements cannot be used to supply blast furnace coke. For example, the coals of southern Illinois, while excellent for most purposes, are not ordinarily useful for making coke, and the iron and steel industry of the Chicago-Gary region obtains 96 per cent of its coking coals from the remote district of southern West Virginia and eastern Kentucky at considerable expense for overland transportation.[17] Only 37 per cent of all the bituminous coal mined in the United States in 1940 was suitable for coking.[18] Although the Los Angeles and San Francisco

[17]Voskuil, Walter H., *op. cit.*, page 343.

[18]*Ibid.*, page 345.

districts are well located with respect to markets and are competitive with the Atlantic and Gulf coasts with respect to ore importation, they are too far from abundant supplies of coking coal to offer great promise. However, technological progress may in the future make available for metallurgical coke some coals which cannot now be so used. But, at the present time Baltimore, Mobile, and Houston appear to be the cities whose competitive positions will be most enhanced by the forthcoming exhaustion of the open pit ores of Minnesota.

However, at this point some technological trends should be noted, each of which tends to release iron and steel production in some measure from the chains of proximity to raw materials. Two developments bear upon coking coal and make economic access to this material of lesser importance than formerly.

The first of these is the high degree of coal preparation which is being developed at many mines. Processes of selection and cleaning of coals are progressively reducing the amount of waste tonnage which needs to be transported from mine to coke oven. This means that the number of tons of coking coal which have to be shipped per ton of pig iron is undergoing a long-run decline, so that in the future a blast furnace may be located at a greater distance from the coal mine without the present disadvantage in transportation cost.

The second is the development of pressure top blowing in the operation of the blast furnace. Executives of the Republic Steel Corporation who have carried on extensive experiments with this technique report coal savings per ton of pig iron in the general magnitude of 10 per cent, and it seems reasonable to expect future savings to exceed this percentage as the technique is further developed. This reduces the transportation cost of coal still further. The process is sufficiently developed that executives of this company expect to have seven of their blast furnaces converted to pressure blowing by the end of 1949.[19] These two developments mean that in the future, blast furnaces may be economically located at greater distances from coal mines. They promise to improve further the relative advantage of Gary over Pittsburgh, reducing the freight outlays of the long haul from the southern Appalachian fields to the Chicago district.[20]

The Role of Continuous Casting

A third technological development of some importance is the direct or continuous casting of billets. This technique promises in the future to be useful to steel-making operations remote from blast furnaces. Some of the steel production of California is of this character. On the Pacific Coast and elsewhere the remoteness of good coking coals has kept blast

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[19]Wilson, Jean, writing in the *Chicago Journal of Commerce*, April 26, 1949, page 16.

[20]For an excellent analysis of this and other factors bearing on the general subject of iron and steel locations see: Isard, Walter, and Capron, William M., "The Future Locational Pattern of Iron and Steel Production in the United States." *The Journal of Political Economy*, Vol. LVII, No. 2, April, 1949, pages 118–133.

furnace capacity below the requirements of the market so that an unusual percentage of steel production, lacking adequate molten pig iron at hand, has been devised to use relatively small amounts of cold pig iron shipped in from a distance and large amounts of local scrap. Such steel production is under some serious handicaps. One is that there is a loss of fuel in melting the charge in contrast to that of a steel furnace charged with molten pig iron. Another is that too high a percentage of scrap in an open hearth furnace reduces the versatility of the steels which the furnace can produce and makes it suited only for special purpose steels.

With respect to the electric furnace, it ordinarily operates with a 100 per cent scrap charge and can make almost any kind of steel, but it remains a high-cost operation on carbon steels although in recent years it has been improving in this respect, especially where electric power costs are low. With regard to these disadvantages of non-integrated steel production, direct casting has little or nothing to offer.

But, a final disadvantage, the necessity for large scale non-integrated steel production, can be relieved by direct casting. At the present time, the large units of equipment immediately following the steel-making furnace place a premium upon a big volume of output and on multiple-furnace plants. The equipment units in question are the soaking pits and the blooming and semi-finishing mills, one installation of which has so great a capacity as to absorb the output of a number of steel-making furnaces and to compel a plant capacity too large for a small local market. The direct casting of steel, while still molten from the steel-making furnace, into billet form eliminates the soaking pits and blooming mill, making possible steel production on a smaller scale for a more limited local market than has previously been ecenomical. The result may be that in many small steel-consuming localities so remote from centers of integrated steel production as to suffer a serious freight handicap on purchased steel, the manufacture of steel in the electric furnace may become a profitable small scale business. This is especially true where electric power cost is sufficiently low to relieve the competitive disadvantage of the electric furnace in the manufacture of carbon steel. However, direct casting is still in the developmental stage and at present is suited only to a limited selection of steel products. Its promise is a future one, and, in any event, its effect upon location has to do only with those steel plants which are deprived in the first instance of proximity to raw materials.

The Institution of F. O. B. Mill Pricing

While the decline in the ore reserves of the Lake Superior District has altered the locational outlook with respect to raw materials, the recent decisions of the Supreme Court with regard to the multiple basing point system of pricing bear upon the relationship of the industry to the market for its products.

For the purposes of this analysis, the United States may be considered as consisting of steel surplus and steel deficit areas. The steel surplus

areas are those which possess steel-producing capacity well in excess of steel consumption, and the steel deficit areas those which consume more steel than they produce. As an example of a steel surplus area, the region enclosing Cleveland, Youngstown, Pittsburgh, and Wheeling produced, in 1948, 42 per cent of the steel made in this country, but the metal-working industries of the area consumed only 9.1 per cent of the nation's metal-working steel consumption.[21] By contrast, the six New England states consumed 6.2 per cent of the total metal-working consumption, while producing only 0.5 per cent, a steel deficit area. It is estimated that Texas received 5 per cent of all finished steel shipped in 1948 while producing only about one-tenth this amount, clearly a steel deficit area.[21a] While the metropolitan area of Chicago is a steel surplus area, its mills are the largest source of diversified steels available to the large market of the Upper Mississippi-Missouri Valley so that, including this corn and wheat belt market, the Chicago market area might properly be considered a steel deficit area.[22]

Now, under the multiple basing point system of pricing, a steel buyer in a steel deficit area could purchase from a distant steel surplus area at a relatively low delivered cost. This is because the steel surplus area would ordinarily quote a price based on a basing point in the steel deficit area. For example, a Pittsburgh mill would quote a customer in Davenport, Iowa, a price based on delivery from Chicago, and the Pittsburgh mill would absorb the freight differential occasioned by the long haul from Pittsburgh. In short, the steel surplus area, notably the Pittsburgh-Youngstown-Wheeling district, shipped to almost all parts of the country east of the Rocky Mountains, quoting delivered prices at all points identical with those quoted from Baltimore, Gary, Birmingham and other steel deficit basing points and absorbing the freight differential as the penalty paid for its distance from the market.

Under the multiple basing point system, the Pittsburgh district absorbed freight whenever it shipped to destinations near other basing points. Usually, the farther it shipped, the more freight it absorbed. Thus, the mill net realized per ton by a Pittsburgh mill commonly varied inversely as the distance of shipment, so that, for example, shipments to nearby Harrisburg or Akron meant a high mill realization and shipments to distant Dallas a low realization.

By contrast, under the f. o. b. mill pricing system instituted in July, 1948, prices are no longer based on the basing point nearest the consumer,

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[21]These comparisons are taken from a news release of the *Iron Age*, relative to its weekly reports on this question beginning in the issue of May 26, 1949, page 72A. Steels taken by metal working industries represent about 70 per cent of all finished steel tonnage shipped.

[21a]*Iron Age*, April 7, 1949, page 137.

[22]"Chicago and Detroit area steel makers produce roughly 24 per cent of the country's annual capacity of 94,200,000 tons, but the seventh (Federal Reserve) district consumes close to 40 per cent of total output."—*Chicago Journal of Commerce*, July 17, 1948, page 1.

and freight absorption is no longer governed by the freight differential between the producing mill and the ruling basing point. To say the least, the situation is a highly confusing one. Let us simplify it artificially by making two assumptions which have been reasonably approached during the steel shortage of the past ten months. Our assumptions will be: (1) that a Pittsburgh producing mill quotes the same f. o. b. mill price to all consumers, regardless of their location so that a consumer in Akron will pay the Pittsburgh price plus freight to Akron and a consumer in Dallas will pay the same Pittsburgh price plus freight to Dallas; thus we are assuming no freight absorption; and (2) that the f. o. b. mill prices at all producing mills at every producing location—Pittsburgh, Birmingham, Gary, Houston, and elsewhere—are identical.

Under these assumptions, consumers in steel deficit areas will buy from Pittsburgh only so long as the steel shortage compels them to, and, as soon as the mills nearer at hand have excess capacity, these consumers will purchase locally. Obviously, the steel industry of the Pittsburgh-Youngstown district under such an arrangement would do little business most of the time and could operate at capacity only during such periods as 1929, 1937, and 1941–49. Most of the time the steel industry, even in steel deficit areas, has idle capacity, so that most of the Pittsburgh-Youngstown industry would be in chronic idleness. Clearly the economics of these assumptions are fantastic.

Therefore, let us assume that the Pittsburgh-Youngstown district, in an effort to keep operating, would still not absorb freight—that is, would continue to charge the same f. o. b. mill price of all consumers, but would make this price so low as to invite business from a distance. To say the same thing another way, it is a reasonable supposition that mills in steel deficit areas would enjoy so much business so much of the time that they would raise prices relative to Pittsburgh. Indeed, in Detroit, Los Angeles, and elsewhere they have done so during the past ten months. The result is an expansion of the market area of the Pittsburgh-Youngstown district and a contraction of the market areas of steel mills in deficit areas. For example, prices in Pittsburgh might be reduced so low relative to Gary that a consumer in Elkhart, Indiana, near Gary, would find it cheaper to buy in Pittsburgh, and only that portion of the Gary market from Chicago westward into the Mississippi Valley, because of its distance from Pittsburgh, could afford to purchase in Gary. This is a more realistic picture of what may be happening.

Bear in mind that for purposes of discussion I am continuing to assume that there will be no freight absorption and that each producing mill will be free to quote a price f. o. b. mill different from producing mills at other locations. These assumptions are not highly unrealistic. Any freight absorption so calculated as regularly to lead to delivered prices at a consuming point identical as between producing locations is now clearly illegal, and the larger steel producers have not yet adopted any other basis of freight absorption. Therefore, uniform f. o. b. pricing still

prevails except for a certain amount of unsystematic freight absorption which has been quoted in 1949 by some of the smaller independents. For reasons which I shall discuss later, it is difficult to see how the steel industry generally can practice freight absorption without doing it in a fashion so systematic as to violate the law as now interpreted by the Federal Trade Commission and the courts.[23] Therefore, let us examine some of the practical consequences of the present pricing system.

The present pricing system means higher steel prices for consumers in steel deficit areas. As the buyers' market progresses, the steel purchasing cost differential in favor of Pittsburgh may become greater as Pittsburgh prices come down. A large percentage of steel production in most of the steel deficit areas is controlled by companies with very large plant investment in the Pittsburgh-Youngstown district. This is true of Gary, Birmingham, Utah, and California. Therefore, it is reasonable to expect these companies to reduce Pittsburgh prices relative to those of Gary, Birmingham and elsewhere so as to extend the Pittsburgh marketing area and to offset its freight disadvantage, as the general price level declines. Admittedly, this would mean low returns to Pittsburgh on sales to points both near and far, unlike the penalty of freight absorption in that the latter was incurred only on distant sales. Nevertheless, with freight absorption removed, Pittsburgh, Wheeling, and northeastern Ohio could afford to underquote other producing centers by a considerable margin and still be no worse off than they were under the multiple basing point system. Therefore, the time may come in the next two or three years when prices of steel at Gary, Birmingham, Granite City, Houston, and other deficit areas remain near the old, 1949, inflationary levels, while Pittsburgh steel prices will have come down along with other raw material costs. This places steel consuming industries in steel deficit areas, such as California and Texas, at a considerable cost disadvantage.

F. O. B. Pricing and Industrial Relocation

Much has been said of the pressure placed upon the steel industry to decentralize as a result of f. o. b. pricing. Of course, some decentralization of the industry may occur. This is particularly true of finishing operations, for example, a Pittsburgh mill, desiring to absorb freight on cold rolled strip to Houston and prevented from doing so by the f. o. b. pricing policy, might establish a trimming and cutting shop in Houston. The steel producer could carry almost to completion the production of the steel in Pittsburgh. Then, still retaining title to the steel, he could ship it to his Houston finishing mill, representing the minimum geographically separable investment. In Houston, the steel would still be in process and would still be the property of the steel producer. Then, upon completion of the final finishing operations, he could sell it to a Houston consumer f. o. b. Houston. Very probably, therefore, the effect

[23]See Triangle Conduit and Cable Company, et al. v. Federal Trade Commission, 168 F. 2d 175 (C.C.A. 7th 1948).

of the basing point decisions will not be to decentralize that portion of the steel industry engaged in blast furnace and steel making operations. The economics of raw materials and of integration are too compelling to yield to such a decentralization. Rather the industry may pull apart at some point in the finishing of steel, so that small finishing shops owned by the integrated steel producers may be built in major steel deficit locations. However, this will be true only of finishing operations which can be performed economically in quantities small enough for local markets.

But, not enough has been said about the pressure of f. o. b. pricing upon the relocation of those industries which consume steel. The basing point decision tends to pull the steel producer and the steel consumer together. But, the production of iron and steel in blast furnaces and steel-making furnaces is a highly immobile operation and is likely to resist the pull for a long time. By contrast, steel-consuming industries are generally much more mobile. The relatively lower cost of steel in the Great Lakes area and in the Pittsburgh district will make these regions more attractive to the machine and other steel-consuming industries.

Pittsburgh is becoming a very attractive location for certain kinds of steel buyers, notably those with the following characteristics: (1) a high ratio of steel cost to total cost, that is, the performance of relatively few operations by the fabricator upon the steel purchased, (2) low-priced steel in which, therefore, freight is a high percentage of steel cost, and (3) a high scrap rate because of rejects or trimmings. Many pressing and stamping operations fall into these categories. Proximity to Pittsburgh means not only a low cost for delivered steel, but, in addition, a high realization on scrap, and wherever trimmings and other scrap generation run high, the motive to move to Pittsburgh is very strong. These observations apply not only to the general Pittsburgh region, but also to other major steel producing centers. Therefore, because of the immobility of the steel industry and because of the relative mobility of steel consumption, contrary to common opinion, the basing point decision may be an economic blow at the steel deficit areas and a lesser penalty upon those with a steel surplus.

News of Pittsburgh growth is impressive. "The Chamber of Commerce reports that companies capable of employing 6,000 new workers in the area came to Pittsburgh in 1949. Of the 50 new concerns to arrive, General Motors, Continental Can, and Kelsey-Hayes are the largest."[24] The steel mills of Pittsburgh will hardly suffer a severe decline because of competition from Gary, Birmingham, and Los Angeles as long as so much production in Gary, Birmingham, and Los Angeles is controlled by the very companies which own so much of the Pittsburgh-Youngstown industry. But, the steel consumers—automobile parts, railway cars, mining machinery, and others—may move into proximity to Pittsburgh to the disadvantage of the newer industrial areas of the South and West.

[24] *Business Week*, March 12, 1949, page 68.

Freight Absorption and Price Competition

Thus far I have been assuming little or no freight absorption. Only some of the smaller independents now feel that freight absorption of any kind is legally safe. If freight absorption should become more widespread, it will have to be "unsystematic," that is, it will have to be so calculated that a given consuming point will be quoted different delivered prices by different producing points. Let us consider the dilemma of a producer in a steel surplus area planning to absorb freight, taking, for example, a Pittsburgh producer quoting for a customer in St. Louis. This producer may not legally quote a price identical with that of his Gary competitor (except as an occasional accident), and it would make no sense for him to quote either a higher or a lower price.

Suppose he quotes a higher delivered price than the Gary mill. He will not get the business and he might as well not have quoted at all. Suppose he quotes a lower price. Then the Gary mill will reduce its quotations correspondingly, and the Pittsburgh producer will be in the same relative position as before, but at a lower price level. The demand for steel is extremely inelastic, so that at any time there is only so much steel to be sold by the industry as a whole, almost regardless of price. Therefore, price cutting is immediately met, and the competitors are right where they started as to tonnage, but at a lower price level. Obviously, it does not make common sense in this situation for a producer to cut prices.

Nevertheless, it may happen that in the general confusion of the present pricing practice, price cutting may get under way. Under the multiple basing point system, every producer could readily calculate his competitors' quotations at any delivery destination. Delivered prices were easily determined and met. But, in the present confusion, this is not true. In the present uncertainty as to delivered prices, a producer may occasionally underbid a competitor without particularly intending to do so, leading to price competition. While the steel producers complain that the order of the Federal Trade Commission leaves them in confusion and uncertainty, it may be that that is just the result the Commission desires. In the confusion and uncertainty, price cutting may get started.

Should price cutting in the steel industry become widespread, there is reason to expect as an antidote either more financial combination in the industry or a very rigid price structure. The industry cannot stand active price competition. This is because of the high variability of demand, the generally prevalent idle capacity in most years, the high ratio of fixed costs to total costs, and the extreme unresponsiveness of the demand for steel to price reduction. For all these reasons, during a period of depression active price competition would spell financial disaster and widespread plant abandonment. To avert these consequences, the producers, once burnt by price competition, would probably resort to surreptitious collusion, financial combination, or, through independent action by each producer, to adoption of a price structure subject to highly infrequent

change, the last to avoid the confusion from which price cutting might arise. In a sense the steel industry is a natural monopoly. Possibly, as Judge Elbert Gary once recommended,[25] it should be regulated by the federal government as a public utility.

The Growth of New Steel Markets

Since 1939 the markets for finished steels have undergone a considerable shift, notably in the growth of steel consuming industries in California, Texas, and the Southeast. This raises a question as to whether or not the steel industry faces a future of growth in these areas. By way of answer, it is doubtful that the mere growth of these markets as such will warrant much, if any, future growth of the steel industry in California, Texas, and the Southeast. Rather, future growth in these areas will result from the long-run outlook for new ore sources, from changing technologies, and from f. o. b. mill pricing along the lines I have already discussed.

We must remember, in the first place, that the steel industry in these areas underwent considerable growth during World War II. Taking Texas for example, we may consider employment in durable goods industries as a measures of the market for steel, because the building up and maintenance of these industries represents steel consumption, and because a number of them consume steel as a raw material. Employment in the durable goods industries of Texas went up by 126.5 per cent from 1939 to 1948. But, at the same time, employment in the iron and steel industries of Texas increased by 156.5 per cent.[26] Of course, this comparison may overstate the recent growth of the Texas steel industry. Probably the industry in Texas contains a higher percentage of finishing operations than is true of the steel industry for the nation as a whole, and finishing operations include a larger amount of labor per unit of product than do the preceding steel-making processes.

In 1948 the steel industry of the Pacific Coast is reported to have produced just about half of the consumption of the seven western states.[27] Although this demonstrates that the Pacific Coast is a steel deficit area, it does not lead to any conclusion as to the desirability of further steel expansion there. Doubtless western consumers feel that more steel producing capacity would lead to lower quotations to the benefit of western industry. On the other hand, further Pacific Coast expansion would encounter the underlying problem of raw materials, and steel produced from a disadvantageous raw materials basis including too high a percentage of scrap and excessive transportation costs on coal and ore might lead to a locally-produced steel supply fully as expensive as that

[25]Report of the Stanley Committee, House Report 1127, 62nd Congress, 2nd Session, 1911.

[26]Bureau of Business Research, The University of Texas, "Estimates of Manufacturing Employment in Texas," data derived in co-operation with the U.S. Bureau of Labor Statistics for respective months and years.

[27]*Iron Age*, May 5, 1949, page 116.

brought in from the east and south. It should be noted further that 1948 was a year of unusually high steel consumption, not likely to be repeated soon again, so that for most of the time from now on, the Pacific Coast will probably be much less of a steel deficit area. Reports of cutbacks in steel production schedules scattered and fragmentary though they are, indicate the beginnings of this change. Warehouse steel prices at Salt Lake City on structural shapes and plates have, for the first time in history, been reduced to approximately the same level as in eastern industrial cities,[28] a further indication that demand in the far west is declining relative to steel capacity. Indeed, considerable quantities of Pacific Coast steel are being shipped into the Southwest under freight absorption. One is almost compelled to conclude that steel expansion on the Pacific Coast would hardly be an economic move in the foreseeable future.

With regard to the Southeast, its rated ingot capacity was expanded by 39 per cent from 1938 to 1949, in contrast to expansion for the nation as a whole of only 17.5 per cent.[29] The market in this region has been growing just as it has in Texas and on the Pacific Coast. Furthermore, Alabama, in particular, is well located, not only with respect to those raw materials within her own borders, but with respect to imported materials. It should be noted that at present rates of extraction the Alabama ores have a much longer life ahead than have those of Minnesota. The possibility of ore importation, even to Birmingham, at relatively low costs for shipment from the Gulf Coast at Mobile, provides Birmingham producers with greater flexibility in ore analysis and, therefore, in operating practice and product composition. The Tennessee Coal, Iron & Railroad Company has, on occasion, improved blast furnace productivity with imports from Sweden and Brazil. Thus of the three major steel deficit areas considered, the Southeast appears to have the best combination of expanded steel markets and raw material access.

Nevertheless, with regard to all steel deficit areas, we now appear to be moving into a period when there will not be any steel deficit any place excepting in occasional specific products. The concept of a steel deficit which has become so commonplace during the past eight years is actually an unusual one. Excepting for finishing processes which are geographically separable, the steel industry does not migrate appreciably during the long periods of idle capacity. So, with respect to the pull of new markets, this pull will hardly be effective in the establishment of new blast furnace and steel furnace plants until we again move into a steel shortage. At that time the raw materials problem percipitated by the decline of the Lake Superior ores, the disappearance of systematic freight absorption, and the development of new technologies will combine with the growth of new steel markets to bring about more of a geographical scatter-

[28] *Iron Age*, May 19, 1949, page 118.
[29] *Iron Age*, March 3, 1949, page 152.

ing of the industry. For the years immediately ahead we must expect the map of the American steel industry to show very little change.

A Note on the Future of Pittsburgh

In closing, may I make a prediction as to Pittsburgh. It is this: that, apart from her normal share in the business reversals of the nation as a whole, Pittsburgh faces an extremely good future and shows no indication of becoming a ghost city. Basically this is because of the location of Pittsburgh. This city is built in the midst of an almost unlimited reserve of high quality bituminous coal. With the continued development of improved mining and distillation methods, the coals of western Pennsylvania may in time become a major source of oil and gas. Pittsburgh has long been known as the steel city. It might be better if she were known as a coal city. Her steel industry has been based on her coal, and, although cheap coal is now less of a reason for locating blast furnaces in Pittsburgh than it was formerly, it is still important enough to hold in Pittsburgh most of the iron and steel production already located there. Furthermore, cheap coal means cheap power, and with the development of the electric furnace as well as the increased use of electricity in other industries, the advantage of coal remains. The f. o. b. mill system of pricing is drawing steel-consuming industries into the Pittsburgh area, bringing a wholesome diversification of employment for capital and labor.

Pittsburgh also has permanent advantage in her transportation routes. Located at the junction of two navigable rivers, and the originating point for traffic on the long Ohio-Mississippi River transportation system, the products of her natural resources are readily moved out to a huge marketing area to the west and south—Louisville, Cincinnati, St. Louis, Memphis, and New Orleans. Pittsburgh possesses in permanent form the historical foundation for a great industrial center: a wealth of natural resources and a pivotal location with regard to transportation. Whatever changes may come in markets and technologies, this combination is hard to beat.

FIVE YEARS OF ACHIEVEMENT AT ALTOS HORNOS STEEL COMPANY

H. R. PAPE

General Manager, Altos Hornos, Mexico

We live in an era where industrialization, so necessary to economic strength and independence, no longer is left to chance nor depends upon the animation and ambition of a few individuals, nor merely upon developed market and raw material advantages. Industrialization has become a planned science which when properly applied, taking cognizance of results obtained in other areas and of the condition surrounding these results, can give a fairly complete and correct answer as to what may be expected in the long pull.

The importance of industrialization has been recognized by government and made an integral part of government programs, so as to develop economically productive employment for all available labor. Great efforts have been made to set up programs of industrialization based upon the findings of economists and engineers.

Economists were early to recognize the relation between economic wealth and stability, industrial activity, and its consequent effect upon standards of living in a country, as related to the steel consumption per capita within said areas.

Industrial and economic planning, therefore, has always given considerable importance to the possibilities of a steel industry within the area under consideration, frequently in spite of apparent extraordinary risks and difficulties with respect to raw materials, transportation, and immediate market, such that private interests and capital cannot be found as sponsors, with the result that practically one-hundred-per cent government financing and control is necessary. I admit without hesitation the importance that must be given to the steel industry in all studies of national industrial economy, but it is difficult to conceive positive or lasting advantages from an installation whose capacity of production and whose access to raw materials are such that the economic advantages are not plainly visible to private capital and initiative. The intricacies and complexities of a steel business as it exists today, producing the products required by its market in the qualities necessary and at reasonable prices, are such that a good proportion of private initiative, ready to give fully of itself, is necessary in order to build up and strengthen the ties that bind together such an organization into an efficient unit that can stand on its own feet and produce satisfactory results.

This does not at all preclude government aid; in fact, in areas that are underdeveloped industrially, the investments required in the minimum plant, although not equal to those required to be competitive in the United States, are so tremendous, proportionally to the wealth of the country,

that unless government aid is available, most frequently the bases for a self-sustaining steel industry cannot be set up.

In 1941 the proper circumstances existed in Mexico for the organization of a steel plant specialized in the manufacture of steel plate, sheets, tinplate, cast iron pipe, and welded steel pipe. Mexico's consumption of iron and steel products was estimated at around 380,000 tons of finished products per year with a production in the country of approximately 130,000 tons and imports of approximately 250,000 tons. The proportion of the imports which represented products already made in the country but in insufficient quantities was not given consideration by the founders of Altos Hornos de México in view of the fact that in the flat-rolled products field, which is a speciality in the steel industry of such importance that it can separate itself, there ware already sufficient imports to support a small, specialized, well-founded plant. Average yearly imports of flat-rolled products during the years of 1937 to 1941 inclusive were as follows:

	Tons
Plates	7,000
Sheets	16,500
Tinplate	17,000
C.I. Pipe (estimated)	9,000
	49,500

There was no lack of iron ore, coal, limestone, fuel oil, and other basic raw materials required in the country, although extraction and benefaction were not sufficiently developed to take care of much additional requirement. The government had very wisely set up a vehicle for the sponsoring of such new and additional industrialization as could not be handled by private capital entirely because of the size of the various jobs in hand, this vehicle being the Nacional Financiera, S.A., a financial institution comparable in the United States to the RFC. In other words, there existed the basic elements for a well-founded steel expansion program.

A private group of Mexican bankers and industrialists, recognizing the existence of these necessary elements, originally had in mind the establishment of a plant to produce only cold-rolled sheets and tinplate, using imported hot-rolled strip in coils as raw material, in order to obviate the complications and tremendously expensive basic installations for converting Mexican raw materials into the semi-finished steel coil necessary for producing sheets and tinplate. Technical advice was sought in the United States and their plan came to the attention of The Armco International Corporation, foreign subsidiary of The Armco Steel Corporation, one of the important producers of flat-rolled products in the United States. Preliminary studies indicated that a mill based on re-rolling imported steel would be entirely at the mercy of foreign suppliers, a situation which was not likely to be in the interests of the proposed new enterprise or in the national interests of Mexico. It can easily be imagined the addi-

tional difficulties that Altos Hornos de México would have experienced during the period of allocation of steel from the United States—its only source of supply during the war years—had the original plan been followed. The soundness of a project using Mexican raw materials was immediately understood. However, in view of the tremendous investments required in order to beneficiate and convert these raw materials into a usable raw product for a sheet mill, it was necessary to call upon the already prepared and functioning industrial financing agency of the Mexican Government conceived for just such problems, namely, the Nacional Financiera. Although the plant as contemplated, calling for an annual production of 18,000 tons of tinplate, 15,000 tons of cold-reduced sheets, 15,000 tons of steel plates, and 7,000 tons of cast iron water pipe, was conservative with respect to the market requirements and small as compared to operating steel plants in the United States, it represented a tremendous effort, financially and technically, in view of there not being available excess electrical power, excess coal and coking facilities, supporting organizations such as machine shops, specialized engineering consultants, and all of those items necessary for the design, construction, and maintenance of a modern heavy industrial plant. Private initiative alone could hardly have overcome these numerous formidable obstacles without the supporting hand and approval of the nation in such form as the Nacional Financiera offered, whereby individual initiative and ambition are not thwarted by government, but are aided and encouraged with the spirit of getting the job done for the good of the whole.

Although deposits of iron ore were known to exist in many parts of Mexico, the only known adequate supply of coking coal was that of the Sabinas coal fields in the State of Coahuila in northern Mexico, some 50 to 60 miles south of the Mexico-Texas border town of Piedras Negras. Fortunately, the north-central part of Mexico was also known to contain a number of iron ore deposits both in the same State of Coahuila and in the neighboring states of Durango and Chihuahua. Market studies on the other hand showed that Mexico's major steel consuming center was in and around Mexico City, in the central part of the country, some 600 miles to the south. It was obviously desirable, therefore, to assemble the coking coal and ore at some intermediate point, preferably in northern Mexico, close to the raw materials, in order to keep freight costs at a minimum. The matter of water supply was also very important, since northern Mexico is semi-arid in climate. After giving consideration to a number of possible plant sites, the ancient city of Monclova—early capital of the tri-state district of Texas, Coahuila, and Zacatecas—was chosen.

Monclova had the advantage that it was at the junction of two railroad lines, one from the Sabinas coal basin to the north and the other from Chihuahua to the west, the location of iron ore deposits of substantial size in the north-central part of the country. Monclova also possessed an adequate water supply in the Monclova River. The city of

Monclova itself had greatly declined from its former size, and its population was only approximately 5,000 persons, but there was no reason to believe it could not support a much larger number, as it had in the past.

By the end of December, 1941, an agreement was reached between the group of Mexican businessmen and bankers, the Mexican government as represented by the Nacional Financiera and The Armco International Corporation, for the formation and financing of a proposed new integrated Mexican Steel Company, to be called Altos Hornos de México, S.A. The original financing was based on $16,490,000.00 pesos of common shares, $5,820,000.00 pesos of 7 per cent cumulative preferred shares and a 6%, 15-year mortgage bond issue of $30,000,000.00 pesos, or a total capital of $52,310,000.00 pesos.

The Company's formation was predicated on a number of options which had been obtained previously on certain essential major units of steel mill equipment, primarily on an existing blast furnace near St. Louis, Missouri, and a combination universal plate and hot strip mill at Indiana Harbor, Indiana. These units, together with a number of other steel mill items which had also been placed under option early in 1941, were purchased early in 1942, as soon as the new company was formed. Work was begun immediately on dismantling them for shipments by rail to Mexico.

The existing essential equipment located in various parts of the United States, available in most cases because of plant expansion programs carried out by mill owners in previous years, made Altos Hornos an immediate possibility. It was recognized that the delivery promises on new heavy mill equipment, which was already skyrocketing in price in 1941, would not permit an early realization of the plan for an integrated plant. This was later borne out in the case of a Brazilian Steel Mill which was conceived, organized and under way almost two years before Altos Hornos was organized and where orders for heavy mill equipment placed with the manufacturers in the United States were finally only completed so that they could get under partial operation approximately two years after Altos Hornos was already blossoming forth with finished products.

Through Armco and various friends in the steel business, information was gathered together concerning available heavy mill equipment that might be needed; a blast furnace was located on the Carondolet quarter of St. Louis. This furnace had been shut down immediately after the first world war, and very little attention had been given to its condition during the interim period. Vandals had stolen much of the copper and certain machinery parts. The furnace had been sold to scrap dealers for unpaid taxes. Inspections by several experts brought forth varied opinions as to the feasibility of making use of the essential parts of this furnace, yet here were tons of recuperable furnace parts which as such had only scrap value but which in the hands of engineers with knowledge, determination, and versatile thinking could be rapidly converted into an

operable furnace at a time when all steel equipment was becoming difficult to obtain. Any plant operator likes to have new equipment with full modern conception throughout, just as much as any automobile enthusiast likes to have a new automobile, so the decision to purchase this pile of furnace parts and convert it into a fairly modern unit was not easy to take. Immediately that we had arranged access to the furnace a contract was concluded with Day & Zimmermann of Philadelphia, power plant engineers who had recently formed a steel plant engineering division and who were one of the only groups in the United States with a few qualified steel draftsmen available for outside work, to supervise the dismantling in St. Louis and the redesigning of the furnace in accordance with modern blast furnace principles and in keeping with the reasonable possibilities of the situation. The first young Mexican engineers, just out of school, hired by our young company, were sent to St. Louis to assist in this dismantling operation, and one of these young men has followed this furnace through dismantling and rebuilding and is now superintendent in charge of operation. We set up in St. Louis, on the site of dismantling, a small machine shop in view of the fact that no facilities were yet available in Monclova. The greater portion of all blast furnace parts that required repair and rebuilding was handled in our own temporary shop in St. Louis, as soon as the parts were dismantled. Thus, we had coming into Monclova, for the greater part, structures ready to be put up. The spirit of friendship and collaboration between our organization in St. Louis and quite a number of very important personalities of the city of St. Louis is an indication of the ready and easy understanding that can exist between peoples of different countries once they are in close contact and get to know each other. Engineers of Altos Hornos who worked in St. Louis still remember, with satisfaction, good friendships established there and how cool St. Louis beer can be on a hot, mucky day. To me this represents one very realistic phase of the Good Neighbor Policy.

As the project called for the manufacture of sheets and tinplate and since the cold reduction process was deemed to be the most feasible method for producing a high quality competitive sheet for the Mexican market, it was necessary to locate equipment for the production of hot-rolled strip. In the United States, where the market is large and where the minimum size plant, to be competitive, must turn out approximately one million tons of finished products per year, the equipment essential for making strip is very costly but has high rates of production. Our problem was to produce only 100,000 tons of strip and plate per year, and consequently we could not think of the orthodox, extremely costly installations used in the States. We located a universal plate mill which had been used by the Youngstown Sheet & Tube Company some years before to manufacture strip and which later had been taken out and replaced by continuous equipment in view of their desire to expand production. Again experts were consulted as to the adaptability of this existing equipment for the purpose we had in mind, and the opinions were wide

and varied. The mill was purchased on a ton basis, for less than what scrap has been bringing during the last several years. We desired to have it checked and rebuilt, and arrangements had been made with one of the largest machinery builders in the United States to handle this job. However, we had no sooner shipped the first cars than we were advised that due to priorities placed upon them by the Government of the United States, it would no longer be possible for them to do our job. With no shops in Mexico capable of handling this big equipment, we found ourselves in a very awkward position. However, we decided at once to put up a machine shop in Monclova, big enough to handle the job, and in the meantime we co-ordinated several shops in Memphis, Tennessee, none of which individually was large enough to handle the work, scheduling them to start the rebuilding job by using the combined facilities of these shops as one unit. When we had the Memphis situation organized to where we began getting results, once again we were thwarted by higher priorities, and our job was thrown out. Fortunately, by that time we had constructed and ready for operation our machine shop in Monclova, but, unfortunately, we had no trained machinists. By this time, from previous obstacles encountered, a mere matter of lack of trained personnel was not regarded as a tremendous problem, so we set out to train the personnel, and we rebuilt the mill.

Steel structures were, like everything else, skyrocketing in price and deliveries promised were outside of our admitted schedules, so it was decided to purchase existing buildings suitable to our needs or obtain structures to be dismantled and design our basic buildings from structural profiles made available from these dismantling jobs. We were able to obtain all of the steel from a race track dismantled in the vicinity of Cincinnati and a railroad bridge which spanned the Ohio River. The structural steel made available, along with several other buildings which we dismantled ourselves in southern Illinois, using engineering personnel which we sent from Monclova, supplied the steel for the fabricating and constructing in Monclova of all the basic buildings for the steel plant and rolling mill. We purchased for this purpose an abandoned structural fabricating shop in Kentucky, moved it to Monclova, started a school teaching available labor layout work, welding, cutting, riveting, and proceeded with the job. What was left of this structural shop, after the basic part of the plant was completed, was the basis of our starting our present fabricating shop, which is shipping finished plate fabricated products all over Mexico.

We located a ladle crane for lifting 65 tons of hot liquid steel in the plant of the Lukens Steel Company in Coatesville, Pennsylvania. The crane was old but built of solid stuff and was immediately available in view of plant expansion planned by Lukens. The girders of this crane weighed approximately 80 tons and were the first pieces of equipment to arrive in Monclova. Their arrival was the occasion of a great festivity by the townspeople. These girders were immediately unloaded by hand

with no mechanical aid or devices and without taking into consideration that it was possible, by the removal of a few bolts, to lighten the load by half. This crane was rebuilt in Monclova, is still working today and is now capable of lifting 50 per cent more load than its original capacity. In the meantime, due to the increased production of our Steel Department, it has been supplemented with a 225-ton capacity crane on the same craneway.

Our plans necessitated the availability of considerable electrical power. All through Mexico there was a great shortage of power, so this meant that a power plant had to be built, and power equipment was as high, if not higher, on the priority lists than the tools of heavy industry. We finally located used turbo-generator sets which were purchased through a broker. However, during the inspection of this equipment we ascertained that the original owners were anxious to clean out their boiler house, with the result that we purchased available boilers at a very low cost "as is, where is." It cost us more to dismantle the boilers and put them on cars than we paid for them, but we had boilers. With the equipment located, we contracted the design of the plant with Day & Zimmermann, power plant engineers of Philadelphia, and proceeded with the construction with our own personnel. We probably had more trouble with the power plant than with all the rest of the plant, principally because of the difficulty in securing supplies and accessories during the early war period and the consequent necessity of repairing and rebuilding second-hand equipment which we could pick up. We had to go as far as purchasing scrap valves from the oil fields in Texas, rebuild, refinish and remachine them in order to have valves available, and naturally, men had to be trained to do the job on these valves as well as on other equipment.

It was decided to build the plant close to the Monclova River to facilitate taking water from the river for plant purposes and returning to the same river all excess water, in view of the river's importance to the agricultural economics of the region. This required the building of a railroad spur for which it would take some time to get the necessary materials and complete the construction. Yet, construction schedules for the plant itself called for starting up our structural fabricating shop, immediately. To gain time, this shop was put up at the railroad station of Frontera, some 5 kilometers away from the plant site and equipped with a steam crane and other unloading and handling facilities; and as equipment, structural steel and other materials came in, they were unloaded, cleaned up, measured and inventoried, and this information passed on to our drafting departments so that drawings could be changed in conformance with structural materials available. In the meantime, men were being trained for handling layout work and structural fabricating in this temporary shop. All of the basic buildings of Altos Hornos were built in this temporary shop. Around the shop we had accumulated thousands of tons of structural steel members and second-hand steel mill equipment, most of which had to be rebuilt. To the unaccustomed eye it

looked to be a scrap yard; to the enthusiastic young engineering staff of Altos Hornos it was a storehouse of wealth. To the first President of Altos Hornos, General Abelardo L. Rodríguez, ex-President of Mexico, this pile of somewhat rusty and tangled up machine, equipment, and structural steel was of considerable worry, to the extent of his calling to the management's attention, in very comprehensive words, that he sincerely hoped that we knew what we were going to do with such a "pile of junk." Fortunately we had acquired what we needed, and we had built an organization that could forge it into shape. Naturally there were desperate moments full of grief and anguish for the whole organization, but it is my humble opinion that the spirit that exists in Altos Mornos today, of determination and progress and confidence in the future and willingness to work, was forged and made solid by the troubles and difficulties encountered and overcame during the preliminary organization and construction period.

Living conditions in Monclova during the first few years were not the best. There were no paved streets, with the result that one was either smothered with dust or up to one's knees in mud. One small diesel electric generator which was capable of producing current three or four nights a week, but only enough to cause a lamp bulb to be barely visible in the dark, existed. The only hotel in town, although clean, was completely without any facilities. Altos Hornos proceeded with the organization of a semi-modern boarding house complete with running water and electric lights, where foreign technicians and Mexican engineers could be lodged and fed. Arrangements were made to pave the two main streets, which eliminated for the greater part the dust problem. Not all of the foreign technicians who were brought in from such industrial centers as Chicago, Pittsburgh, Cleveland, Detroit, and Cincinnati, were willing to put up with the inconveniences of the industrial frontier, and for a while for every foreign technician on the job in Monclova there was either one on the way home or on the way down until, finally, by screening and elimination, we established a group of men with the experience we wanted and at the same time with personality necessary to the situation and with a liking for the semi-frontier life. These men, who finally became imbued with the spirit of the undertaking, did a wonderful job for Altos Hornos and at the same time proved themselves to be good ambassadors of the Good Neighbor Policy and have left behind good feeling and understanding.

There existed no paved road from Monclova to Eagle Pass, Texas. Neither had the final project of a road all the way from Saltillo to Monclova been decided upon, so transportation was difficult. Saltillo to Monclova took approximately eight hours, whereas now there exists a good road all the way from Eagle Pass through Monclova to Saltillo, and normal driving time from Monclova is two hours, with no dust.

The first shipment of material from the blast furnace arrived in Monclova on April 27, 1942. Additional materials continued to arrive through-

out the spring and summer, and construction was officially started on October 5, 1942. Twenty months later, on June 2, 1944, the blast furnace was blown in, representing a satisfactory construction record during war time in view of all the difficulties connected with priorities and material shortages in the United States. Four months later, on October 9, 1944, the first open hearth furnace was lighted up and the next day the plate mill was started. Thus, only two years after the start of construction, the plant produced modern hot-rolled steel plate from ingots. The production of modern, flat-rolled steel products in Mexico within the short period of three years between the original conception and its accomplishment in practice represents a record comparable to similar construction being carried on in the United States at the same time, even though the jobs in the United States had full government priority.

The cast iron pipe plant began operations on August 9, 1944, two months before the open hearth and rolling mill. The cold rolling department, all the major equipment of which had to be purchased new, officially started production in February, 1946. The first hot-dipped tinplating unit went into production in February, 1946.

Altos Hornos, in obtaining the support of the Board of Economic Warfare in Washington and a priority from the WPB, which, although not of the highest rating, was very helpful in the eventual purchase of many highly restricted items, offered that as soon as the steel plant and plate mill were in operation, these facilities would be placed at the disposition of the Allocation Committees in Washington for the supply of ship plate in case that it was still needed in the United States in connection with the war effort. Contrary to the expectations of many individuals, Altos Hornos was completed in time and offered and shipped many thousands of tons of ship plate against orders of the Maritime Commission in Washington. This ship plate was sent principally to Port Arthur, Texas, and to New Orleans, Louisiana, and was used in the construction of Liberty Ships. The Maritime Commission sent to Monclova its own inspectors to calibrate our chemical and physical laboratory equipment and to verify the materials supplied to see that they were in full conformance with their specifications. Altos Hornos is proud of this performance which is tantamount to "carrying coal to New Castle." As the programs of the Maritime Commission in the building of Liberty Ships were reduced after V-E Day, these orders were withdrawn, and Altos Hornos made its plate tonnage available to the market in Mexico, which was suffering from steel shortage.

The original plant consisted of a blast furnace with maximum output limited to 200 metric tons per day due to lack of blowing capacity and insufficient coke available, two 65-ton capacity open hearth furnaces, one universal hot mill, two 4-Hi cold reversing mills, three centrifugal cast iron pipe machines, and the necessary maintenance shops which were considerably larger than would be usual for a plant of the size of Altos

Hornos, in view of the non-availability in the region of such shop services as is the case in most steel-producing centers in the United States.

The Arabs in North Africa have a saying that "a finished house belongs to a dead man," so you can always find something unfinished or something new going on or planned in a North African house. Such has been the case of Altos Hornos. The plant of Altos Hornos has never been completed and in view of the tremendous growth of the market in Mexico for the materials as produced by Altos Hornos, it would seem that the continuous construction that has been going on, even after the completion of the first well-planned step, will continue for quite some time. Already, the limit capacity of the blast furnace has been increased from 200 metric tons to 425 metric tons per day. The necessary mining operations to support this increased activity have been undertaken. The transportation problem involved has required Altos Hornos going into the railroad business on a large scale. We operate and maintain on the main lines of the Mexican railroads 494 units of rolling stock for the purpose of gathering iron ore, coal, coke, limestone, dolomite, manganese, flourspar, and the numerous other raw materials needed every day in the operation of a steel plant.

The open Hearth Department has been increased from two furnaces to three furnaces, and instead of charging 65 metric tons per furnace we charge 105 metric tons, and the plans are at present to increase this to 125 metric tons per furnace, which would make available 165,000 metric tons of steel ingots per year.

The original capacity foreseen for the cold mill, in sheets and tinplate, was 3,000 metric tons per month. By added auxiliary equipment we are already producing over 4,000 tons per month, and with the completion of a new cold-reducing unit during the latter part of the present year, we expect to increase production to 5,500 metric tons per month. These increases are not based upon national enthusiasm but upon market requirements that have been developed by experience in our business. Contrary to many steel enterprises initiated in other parts of the world during recent years, Altos Hornos has been founded along the lines of the basic steel industries of the United States, starting conservatively, with a reasonably small plant, and feeling our way, developing as the market requires—contrary to building a tremendous plant and hoping that a market can be developed.

The natural and healthy growth of Altos Hornos can be seen easily from the constant increase in total products shipped per year, as follows:

	Tons
1944	4,341
1945	44,004
1946	74,340
1947	75,195
1948	85,942
1949 (Rate to April 30th)	105,000

The various extensions to the plant, completed or under way, have necessitated two refinancing programs; as of February 15, 1944, the share capital of the company was increased from $22,310,000.00 pesos to $40,000,000.00 pesos, the amount of common share capital remaining the same as originally subscribed and the preferred share capital of the company being increased to $23,510,000.00 pesos. Also, arrangements were made with the Nacional Financiera for increasing the 6% mortgage bond issue from $30,000,000.00 to $40,000,000.00 pesos. In view of the tremendous increases in costs of machinery, construction supplies and construction, and also further additions to the expansion program required, in order to take care of the market as of May 31, 1947, a further increase was voted, increasing the common share capital to $60,000,000.00 pesos, however reducing the preferred share capital to $10,000,000.00 pesos. This was accomplished by making available to holders of preferred shares, common shares of the company on a one for one basis. The conversion of preferred shares to common shares is indicative of the confidence and interest that exists in Altos Hornos.

The total products invoiced to the market have increased year by year along with improvements and expansions to the plant, training and experience of plant personnel, conversion of basic steel into more highly finished products. This can be seen from the following figures of invoicing by year from the start, up until the end of 1948:

	Pesos
1944	$ 1,453,000.00
1945	15,395,000.00
1946	36,932,000.00
1947	51,683,000.00
1948	71,354,000.00

The construction of Altos Hornos during the war years was carried on under very difficult conditions; not only were skilled construction personnel and equipment, construction materials, and supplies difficult to obtain in Mexico, but on account of the war it was almost impossible to buy them in the United States. New steel mill equipment was practically unobtainable at any price, but in spite of these difficulties the Monclova plant not only went into production in an unusually short time; it was constructed at an unusually low cost per unit, compared with similar steel plant construction programs carried out in the United States and other places. With the completion of the third open hearth furnace, the cost of the plant and all of its accessory service figures approximately eighty dollars per ton of annual ingot capacity. As comparison, we understand that the Geneva Steel Plant, built for the United States Government, cost between $150.00 and $160.00 dollars per annual ingot ton. The Kaiser Plant in California is said to have cost nearly as much. Neither of these plants is equipped to make as highly finished products as Altos Hornos and both are very much larger Since large size in a steel plant normally tends to reduce the cost per unit of capacity, the cost per

ingot ton of these installations might well have been expected to be lower than Altos Hornos. Actually, they were almost twice as high.

It is our opinon that the matter of a lower original investment cost, in the case of our plant, for a country whose industrialization is not highly developed, whose financial structure is such as to make investment money expensive, is of tremendous importance in order to get the industry started and on its feet, even at a slight sacrifice in departmental costs and overall appearance. Low interest rates and high labor costs prevailing in the United States justify typically modern high initial cost, high capacity, highly specialized plants. The usual conditions in somewhat under-industrialized countries are high interest rates, low labor costs, and the necessity of producing relatively small tonnages but of many diversified products in the same plant. As we have stated, it is our feeling that under these circumstances, in the starting up of new plants, low original cost is of paramount importance to the final success of the venture from a point of view of national economy and interest of the workers and shareholders. The results obtained so far, of the application of this policy, prove that given good technical counsel and experienced and understanding leadership, there are no limits to Mexico's industrial accomplishments.

The policy of Altos Hornos is never to underestimate the importance of men making up the physical working organization and trying to get them to understand that they are not merely performing a job for a wage but that they are building the foundation of a steady source of income and living in Monclova for themselves and their sons in the future and that they are aiding thousands of other Mexicans to find jobs, to live better, and to feel more secure with respect to their future. Altos Hornos employs close to 3,000 men whose average daily pay, inclusive of *prestaciones,* is $17.46 pesos, as compared with the average wage in Monclova, in 1942, of $1.25 pesos per day. The city of Monclova, which was approximately 5,000 inhabitants in 1942, today has over 25,000 people, has its principal streets paved, now has electricity, and will soon have drinking water distribution and sanitary sewage installations. The men and women of Altos Hornos are proud of the results of their combined efforts during the past six years and look forward with confidence to the future. Young engineers were taken fresh from the several Mexican engineering schools and were placed alongside foreign technicians. We purposely tried to develop a father-and-son relationship as quickly as possible, putting the young engineers at the heads of departments and holding the foreign technicians in the background, ready to give good advice and counsel and a guiding hand in a difficult moment. The result of this policy has been satisfactory, and in a few years we were able to develop a staff of Mexican superintendents and department heads thoroughly capable of handling their respective problems, thereby giving confidence and assurance to the workmen that they also could do their jobs just as well as any place in the world, in spite of the fact that they had no industrial background.

The workmen are organized under a national labor union. The Labor Laws of Mexico being considerably more advanced than those of the United States, we have many problems which are a daily occurrence, which we notice are now becoming familiar, slowly but surely, to the industrial groups in the United States. However, by considerate and just treatment we have found that most matters can be settled reasonably and satisfactorily. It is not possible, because of Mexican Labor Law, to permit tremendous and rapid variations in production rates, with respect to market requirements, since it is a long and difficult undertaking to suspend any worker from the payroll. Therefore, the nature of operations of a steel plant in Mexico is somewhat different than in the United States where a plant can shut down or scale down its operations overnight, releasing its workmen. We are obliged to do considerably more planning in advance, with respect to the possibilities of the market, so as not to find ourselves with no market and a full working force that we are unable to lay off.

Today, Altos Hornos is producing sheet metal in practically all of the grades and sizes as required by the very rapidly growing fabricating industry of Mexico. Our sheets are used for the manufacture of furniture, enameled pots and pans, refrigerators, stoves, radios, beds, galvanized water pipe, metallic electrical conduit, barrels, hinges, tools, and an infinite list of modern appliances whose manufacture has only been undertaken in Mexico since the establishment within the country of a regular and sure source of supply of satisfactory sheet metal. Our steel plate is used for the manufacture of locomotive boilers, fuel oil tanks, water towers, mining equipment, chimneys, tank-cars, for ship repairs, barge construction, bridges and electrical equipment. Altos Hornos, furthermore, uses its own plates and fabricates them into large diameter penn-stocks for hydroelectric installations, of which there are many under construction or projected, for the production of hydroelectric energy in Mexico where, due to the mountainous nature of the country, hydroelectric installations are very feasible. Furthermore, Altos Hornos builds pipe lines, boiler parts, light weight plate welded structures, aiming to complement the already existing steel fabricating industry of the country in such specialty lines that were only made possible by the existence of a plate rolling mill in the country.

The scarcity of pipe for gas lines and oil lines that has existed during the past few years held up the expansion of the government-owned Petróleos Mexicanos (Pemex). The existence of Altos Hornos plate in Mexico has made possible the building of a 20″ diameter gas line 150 miles (250 km.) long from the Gulf of Mexico to Mexico City. Now, we are collaborating in the fabrication of 28,000 tons of 12¾″ pipe for an oil line from the Gulf of Mexico to the town of Salamanca, which is in the center of the country. Thousands of tons of our products have been shipped to Galveston, Texas, and used by the McCarthy Oil Company in the completion of gas lines for their new chemical installations. Thousands of

tons of cast iron water pipe have been shipped to Venezuela to aid in the programs of sanitation and better living.

It has been a long departure, in the products that Altos Hornos is making today, from the original plan of producing only tinplate for the canning industry of Mexico.

The road ahead for Altos Hornos de México and silimal heavy industry undertakings in other countries, whose need for economic and social advancement has caused careful industrial planning, is endless. We must develop and exploit more coal and modernize the extraction thereof, eliminating to the maximum the hardships and dangers of this work wherever they exist. We must provide modern coking facilities and proper and efficient use of the gas and by-products from the distillation of coal, as this fits into the economic schemes and necessities of the country. Refractories, so necessary to the industry, must be carefully and tediously developed. Furthermore, we must not lose sight of the fact that all this effort and work is being expended to bring about better living and better schools and to permit more time for the enjoyment of the good things of life. To those men who are interested in helping bring about a more equitable distribution of wealth and economic advancement throughout the nations of the world, there is plenty of work ahead, and the combination of economics and engineering technology, together with tolerant understanding and experience, offers a field where great things can be done for the good of the world.

PROBLEMS OF UTILIZING COAL RESOURCES IN THE INDUSTRIALIZATION OF NORTHERN MEXICO

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The coal industry in Mexico is at present concentrated principally in the existing exploitations in the Sabinas basin. This basin has as reference point the City of Sabinas, in the State of Coahuila, whose geographical location is approximately 27°52′51″ N. Lat. and 101°5′0″ W. Long. In other words, it is located about 100 kilometers due south of Eagle Pass-Piedras Negras, our border line with the United States of America. The mining camps of Rosita, Cloete, Aguita, Palaú· Sauceda, and other exploitation centers such as Rancherías, El Menor, Hondo, and San Felipe are located in this basin.

North of the Sabinas basin other mines have been exploited at Rio Escondido and Villa de Fuente in relatively small scale and at different times.

The Sabinas basin has an approximate extension of 85,000 hectares, theoretically representing a coal reserve of 850,000,000 metric tons. Explorations have been made by means of drill holes at various times, concentrated mainly in the border of the basin, with a smaller number of drillings, in the center of that area. These explorations are not sufficient to determine the volume of the coal reserves with any precision.

Systematic explorations are now being made in the Palaú tracts through which not less than 35 million tons of coal have been located with certainty. According to the indications of the explorations, there are several coal seams at various depths and of different thickness. In general, the lower seam is exploited; its thickness varies from three to nine feet. The upper seams vary in thickness between a few inches and two feet. The intermediate rocks above and below the coal seam are slate, a rather hard clay, sandstone, and coal clays, showing in all known places of the seam a great variety both in thickness and hardness.

South of the Sabinas basin there are the Esperanzas, Saltillito, and Lampacitos coal basins. Exploitations have been made in all of them in former years, mainly before 1910. The most extensive of these developments were at Esperanzas and Lampacitos. At the present time Lampacitos is abandoned. In Esperanzas, which is in the hands of a workmen's Co-operative Society, the coal is exploited in a primitive form and with headings of a rather short scope. Development is being undertaken in Saltillito in a small scale.

Coal in the Sabinas, Esperanzas, and Saltillito basins is coking coal, but this not true of the coals of Río Escondido and Villa de Fuente in the north and that of Lampacitos in the south.

The existence of coal seams is known in the states of Sonora, Chihuahua, Nuevo León, and Tamaulipas, but due to the lack of proper explorations it is not possible to say anything certain regarding industrial possibilities. Geological work, from which the existence of coal seams in the above states is inferred, has been carried on by the Bank of Mexico.

The coal in the Sabinas basin in the State of Coahuila which is best known in the Republic of Mexico because of its having been exploited on a larger scale, can be classified as a bituminous good coking coal, but it is mixed in its natural state in the seams, with impurities which demand prior preparation and washing in order to obtain coke of good quality.

We should consider the coal exploitation in Mexico in two periods: before 1910—the beginning of the revolution—and after the period of active fighting when it was again possible to organize the exploitation of the mines. Before 1910, coal was used as fuel for generating steam. The Mexican Railways consumed almost all of it. The first mines were opened by the International Railway Company under its own corporate name. Operating between Piedras Negras and Durango, it distributed coal from Coahuila to other railways of the Republic. Until recent years the Sabinas basin was almost totally under concession to the National Railways of Mexico.

After 1910, and once the revolutionary period which prevented any stable organization had ended, the manufacture of coke with Coahuila coal started, in order to supply the smelting of non-ferrous metals in the Mexican Republic and later for the iron industry; but during all these years and until very recently, the coal demand was fully supplied by the Rosita, Agujita, Cloete, Palaú, and El Menor mines, and not only that, but Palaú and El Menor, whose life principally depended on the consumption of coal by the National Railways, reduced their operations to such an extent that their combined production was reduced to about 10,000 to 12,000 tons per month. This was the time when the National Railways converted most of their lines to the use of oil.

Based on the coke demand, the Agujita, Cloete, Rosita, and Esperanzas companies built beehive ovens, until the first by-product coke plant was built at Rosita, comprising 40 ovens, most of which are still operating. Later, in 1930, the Rosita Company built another battery of 20 ovens, which, due to modern improvements, give a better recovery than the previous ovens. Thirty additional ovens, under construction at present, are scheduled to begin producing coke during 1949.

Present coke production comes, therefore, from the old beehive coke ovens and the modern by-product coke ovens, the latter located at Rosita. A monthly production of 20,000 to 21,000 metric tons of coke can be obtained from the beehive ovens and a production of 27,000 to 28,000 tons is obtained from the by-product coke ovens when operating at full capacity. Thus a combined production of about 49,000 tons of coke per month is obtained in the district.

Several by-products are obtained at the Rosita by-product coke ovens, among them tar, benzol, toluol, xylol, naphthalene, sulphate of ammonia, creosote, and pitch. Surplus gas, after heating the ovens where 44 per cent of the total is used, is consumed in the boilers or at the zinc plant. The construction of a thirty-oven Wilputte coke battery is about to be completed, and after a heating period of about two months, it will start producing coke and by-products, probably the same as the group mentioned above.

The combined production of the by-product and the beehive ovens is not sufficient at the present time to supply the market. Nevertheless, there are about 190 beehive ovens which can be repaired, and their combined production would represent an increase of about 5,500 tons of coke per month.

At the same time, if the Rosita Company obtains sufficient coal, they will perhaps continue operating the old ovens now in operation along with the thirty new ovens. Production would then be in excess of the market requirements. The main problem at the present time is that of a greater coal production, and for this reason plans have been developed to increase coal production in both Palaú and Rosita mines, the principal producing centers in the district, and in a great number of small mines that have recently been opened. The combined additional production may yield an appreciable tonnage every month.

About five years ago, a new coal and coke consumer entered the market, the new Siderurgical Company Altos Hornos de México, S.A., located in Monclova. At the same time, the Compañía Fundidora de Fierro y Acero de Monterrey, S.A., with the construction of their second blast furnace which has a greater capacity than the former, requires a greater supply of coke. There are also other coke consumers in a smaller scale such as the Compañía Metalúrgica de Peñoles, The Mazapil Copper Company, and a great number of small consumers which are increasing day by day, thus sensibly increasing the demand for coke.

The Compañía Fundidora de Fierro y Acero de Monterrey and the metallurgical units of the American Smelting and Refining Company obtain their coke supply mainly from Rosita. The Fundidora of Monterrey also manufactures coke in beehive ovens at Cloete. Altos Hornos, on the other hand, manufactures coke in Agujita beehive ovens. Palaú manufactures 1,800 tons of coke per month in a small fifty-nine-oven battery of the same type.

At the present time between 80,000 and 90,000 tons of coal are produced in the Sabinas basin, part of which is converted into coke. Coal production tends to increase constantly, and it is hoped that it will increase by 15,000 to 20,000 tons per month in the next six months, mainly from Rosita and Palaú. Good, non-coking, steam coal is produced in the northern part of the district in quantities of relatively insignificant industrial importance.

Impelled by the increasing demand for these fuels, the Mexican Government, within its extensive program of industrialization of the country, has been encouraging the production of coal and metallurgical coke. At the present time complete projects have been prepared for increasing coal and coke production, particularly in the Palaú district. As this extensive program requires several years for its completion, a preliminary project is now under way in Palaú to enable this field to produce about 50,000 tons of coal per month by 1952. Within the plan for extension of Palaú there is included the use of coal cutting, loading and transporting machines underground, the extension of the electric power generating plant which for the time being will have a capacity of 3,750 KW; the construction of a coal preparation and washing plant; and a great number of secondary installations which contribute to the objective of obtaining a greater production.

Projects of considerable importance are also being carried on at the Rosita mines. That enterprise is about to complete the installation of two new turbo-generators of 4,000 KW each, the thirty new by-product coke ovens, and a number of improvements and additions to all installations used in the production and processing of coal.

The production of our coal mines is insignificant when compared with that of the United States. Though our mines have the same or similar general characteristics as any coal mine, I must mention some natural peculiarities adverse to easy exploitation, which characteristics constitute our constant problems in coal mining:

1st. The coal seam is divided in alternate stratifications of coal, slate, and rock; the maximum thickness of clean coal is in general only three to four feet.

2nd. In all deep mines a great amount of gas is produced, this gas production being more intense in Rosita Mine No. 6 than in those of Palaú and Cloete. Furthermore, in all of these mines there exists the constant danger of spontaneous combustion within more or less long periods, depending on the susceptibility of ignition of the coal or of the rocks adjacent to the seam.

3rd. The most serious adverse characteristic of the coal seams in the Sabinas basin is the exceedingly false roof in the mines which limits the width of the galleries and reduces the coal yield for each meter of advance, demanding the extensive use of timber for the protection of the workmen as well as for keeping the entries open.

In regard to my first point, when the coal is cut by hand, the coal diggers are instructed to separate the coal from the impurities, and, in general, when this system is correctly followed, it has been possible to mine a sufficiently clean product to load directly to the coke ovens after simple screening, when it has been produced from a seam which is not too dirty.

When machines and explosives are used, the impurities, especially the thin strata, are inevitably mixed with the coal and increase the ash content. Methods can be introduced to prevent as much as possible mixing

the impurities with the coal, but this is successful only in the cases where the thickness of the seam and that of the strata between can, due to their consistency, be cut in two series—that is, first the coal and then the rock. Anyway, the use of machines and explosives for cutting and loading coal introduces an unavoidable increase in the impurities of the product and requires the construction of washing plants for preparing and cleaning the mine run coal.

There is a small coal washing plant at Palaú, but due to its small capacity, it is to be replaced with one of greater capacity and equipped with modern machinery capable of preparing and washing around 50,000 tons per month operating one shift, or one and a half shifts at most. In this manner it would be possible to mechanize in a rational form the digging and extracting of coal from the mines and at the same time clean the product in such manner as to obtain a coke of adequate quality for use in blast furnaces. A new washing plant was recently installed at Rosita, illustrating my assertion that in exploiting coal mines with machines, it is necessary, as a direct and indispensable complement, to install washing plants for preparing and cleaning the coal.

Referring to my second point, I may say that at the present time we have efficient and powerful fans adapted to the best technique of ventilation in the mines. This fundamentally consists in directing the air current produced by the fan to the most remote places in such a manner that at no time, while the fan is operating, are accumulations of gas possible. The two essentials of a mine explosion are (1) accumulation of gas in explosive proportions and (2) a spark to ignite it.

Fans, coupled with the use of electric safety lamps and the use of electric machines approved against danger of explosion by the United States Bureau of Mines go a long way to minimize that danger. Furthermore, rock dusting with inert dust finely ground is practiced in these mines, the purpose being to neutralize the inflammability of the coal dust. This latter is the element that causes most destruction underground when an explosion is spread, generally started by the ignition of the gas. It is the general idea of all miners in this district that in a mine rock dusted with inert dust, explosions limit and localize themselves, thus preventing a general catastrophe.

Another of the adverse conditions in the exploitation of these mines is the susceptibility of the coal and coaly rocks adjacent to the seam to ignite spontaneously; this is likely to happen when large roof cave-ins occur. The size of the area involved makes it difficult to clean the gallery rapidly, and particularly in the places where the greater part of the coal has been mined, the roof collapses and oxidation starts with the consequent heating which may reach the point of active fire. If there is a gas accumulation in the same place out of the control of the ventilating air currents, the fire may produce an explosion upon getting in contact with the gas. One way to combat the possibility of fire and explosion in such a situation is to seal off the area of collapse, excluding air and

smothering the fire. This is a delicate operation which requires much experience on the part of the miners and endangers the lives of the personnel in charge of this work.

Finally, referring to my third point, I wish to make the following statements: The profitable index of a coal mine is the tonnage produced per man and the competing market price which can be fixed per ton of coal.

During primitive times of coal exploitation and until recent years, 1918 to 1919, the coal was cut and loaded by hand with pick and shovel in all these mines. In this technique the production per man is low, and the miners report to work only part of the week because the digging and loading of the coal is done on a contract basis, and in general they prefer to concentrate their efforts during three or four days of the week and to rest during the remaining days. A very irregular production of coal is obtained in this manner, for which reason the Rosita Company started to use coal cutting machines and electric haulage locomtives underground about 1920.

Coal cutting machines and mechanical equipment for loading mine cars at the working faces started to be introduced recently at Palaú, and a general mechnization of the mines is planned in accordance with the natural conditions which may be encountered, the principal obstacle for the full mechanization being, as before stated, the bad roof conditions.

The use of coal cutting machines of different types in Rosita Mine No. 6 has shown that they cannot be taken advantage of in their full capacity because as soon as the width of the entries exceeds the limits that the roof resistance permits, roof falls occur, regardless of the timbering, causing accidents to the workmen, damage and loss of machines and auxiliary material of the exploitation in general.

The mining engineer in such territory is faced by a dilemma between whose horns lies a delicately balanced arc of profitable operations. Where the structure does not warrant galleries of sufficient width for mechanization, the coal must be cut by hand-tool methods. At the same time, the cost of the coal thus obtained must be kept at reasonable levels. For obvious reasons, the development of the mines when operated by hand is slow because the working faces are harder when advancing in virgin ground as the coal has not been loosened by pressure of the machines. Under such circumstances, in order to stimulate the work of the coal diggers, it becomes necessary to pay a bonus so as to keep them in this harder kind of work.

Later, when the coal seam has been cut by a number of parallel galleries and an increase of pressure has been provoked on the remaining coal pillars, the seam is loosened and the digging becomes easier to the extent that a coal digger which produces three to four tons per shift when working on advance or development faces is capable of producing twice as much or even more when digging coal in the pillars.

Therefore, experience has shown us that the maner of exploiting these mines, taking into account the unsafe or false roof, should be by advancing with machines making narrow cuts, not wider than twelve to fifteen feet and mining the coal with explosives and loading it mechanically, either to the mine cars or to the belt conveyors in order to carry it first from the producing places to the main entries and from there to the surface.

Later, once the exploitation entries and the headings have been cut by the machines, the rest of the exploitation is left for the miners to do by pick and shovel so that, the coal being softer, they can produce greater tonnage per man and at the same time control, within practical limits, the roof falls as the coal is being mined. Summing up, the use of machines, explosives, transportation, and hand mining should be intelligently combined in order to obtain the greatest possible production per man.

I will mention, although briefly, the most important factor in any industry that is, the human factor. It is a very extensive subject which lends itself to comments of all kinds and which would be, by itself, a subject for a much more extensive analysis than the discussion at hand. Furthermore, I will refer to the personnel employed in the mines in this district only.

In the first mines exploited in Coahuila, Japanese labor was used, expressly brought for this purpose by the operating companies. Exploitation of coal mines was unknown in Mexico, and I think that the population in this district was so small at that time that there were not sufficient workmen to operate them.

In accordance with the information I have, the first coal exploitations were carried on with a very high risk coefficient to the personnel. Safety lamps did not exist at that time, and electricity was little used or not at all. The use of an open lamp by every man going underground and the constant presence of inflammable gas resulted in very frequent explosions of all magnitudes with the consequent loss of human lives and in some cases the total loss of the mine.

The mines were of little depth and small extension, located in the outcrop of the seam, and as soon as they reached a distance from the mouth of the mine which made it difficult to extract the coal with the mechanical equipment they had available at that time, they abandoned the shaft and opened new mines, also in the outcrop. This can be verified in Palaú, Rosita, and Esperanzas, where the border of the coal basin has been exploited by the old companies, and now it is necessary to sink deep vertical shafts in order to get the coal.

With the introduction of electric safety lamps in these mines a great improvement was made towards the protection of human lives and of the mines proper. These lamps, as I understand, were introduced between 1920 and 1922 and have been in use since then by the organized companies. They are being constantly improved in what refers to light and safety.

With the introduction of machinery in the Rosita mines and very recently in the Palaú mines, a constant educational campaign has been necessary in order to stimulate the workmen to take the necessary precautions and care in performing their work. Precaution against accidents inevitably brings about efficiency and greater skill in the execution of the work. It is very pleasing to observe that more workmen become technicians and foremen as days go by, with more complete knowledge and special abilities for the execution of the work, and it can be said that at the present time we have competent personnel in this district, not only in the old system of exploitation of the mines but also in the operation of the increasing number of machines.

On the other hand, and comparing the old and modern systems of work, the workmen are completely organized and under the protection of our labor laws. Collective labor contracts between the companies and the workmen are in force in every mining camp.

The standard of living has been considerably improved in recent years. Schools which have capacity for nearly all of the children of the inhabitants have been built in each mining camp. Laborers and employees enjoy better houses and are receiving medical attention and medicines, as well as a number of other benefits such as subsidized co-operative commissaries.

We can mention with pride the progress attained in social welfare for if we look back to old times it seems incredible that there were such hard and dangerous working conditions in the first exploitations of coal in this district until human progress in mechanics and electricity made possible the changes to which I am referring. On the other hand, progress in humanization of the working conditions, not only in Mexico in general but in the Coahuila mines in particular, followed the rhythm of the large working masses of the world in attaining a better life, both spiritual and material.

Nevertheless, there is much to be done not only in the realm of material and moral improvements for the workers, but also in the matter of education to show them that every advantage, every improvement, and every right they gain in their relations with their employers involve at the same time obligations which have to be fulfilled in such a manner that the progress of the industry corresponds to the individual and collective progress the workers attain.

It is gratifying to mention that the workmen in general are every day more conscious of their rights and obligations.

Another vital factor for the coal industry as well as for any other industry or human activity is the transportation service. The mines in this district are reached by railroad through the branches which connect in Sabinas and Barroteran. This transportation has been suffering from the general deficiency of our railroads—shortage of locomotive power and rolling stock in general. No one is to blame; it is the situation; the country has been rapidly progressing during the past ten years, and as the

transportation system has not been increased in the same proportion, general deficiencies had to result. It is fair to admit that notwithstanding the shortage of equipment in proportion to the increase in the transportation demands, they have developed and served the country in a reasonable manner. Isolated individual accidents and carelessness cannot affect the opinion we have of the efficiency of the railway personnel and the administrations they have had.

The present Mexican Government has decided to rehabilitate the National Railways, and we all trust that transportation conditions will greatly improve in the very near future, and we always count on a guaranteed outlet for the mine products as the coal cannot be stored for more than a limited period on account of the risk of spontaneous combustion. An added consideration is the extra handling required for lack of sufficient equipment for receiving the production from the mines, thus increasing its cost.

The companies interested in the transportation of fuel for their respective places of consumption have owned their rolling stock and some of them even locomotive power too. Lately they have been acquiring greater numbers of gondolas for the transportation of coal and coke, and a general well-defined trend is noted towards the necessary, not to say indispensable, improvement of our transportation facilities.

In conclusion, there is a large coal reserve increasingly defined by former and by present explorations still being made. It is a good coking coal which yields a quantity of by-products comparable to that of any good bituminous coal.

It has, as stated before, the principal inconvenience of being subdivided by layers of rock and shale which require a complete cleaning and preparation process in order to utilize, in the manufacture of coke and as fuel, all of its good qualities. However this inconvenience is corrected by means of washing plants, the cost of which, as well as the cost of all kinds of improvements in the exploitation of these mines, is justified by the reserves already discovered and very particularly by the explorations in the Palaú district.

Mechnization of the Palaú district has already been started and should be continued to a convenient degree, taking into account the natural adverse conditions underground, very particularly as regards the weakness of the roof.

The inconveniences mentioned in the exploitation of the mines such as the dirty seam, weak roof, and the great quantity of explosive gas produced have been solved by appropriate methods in the more important mines such as Rosita and will be solved in the same or similar manner in the Palaú mines. The investments necessary to carry on these plans are justified first by the existence of the reserves as already mentioned and then by the increasing demand for these fuels, especially in the form of coke.

Sponsored by the Mexican Government, a program is being developed at Palaú at the present time for the purpose of increasing coal production. Engineering aid from the United States has been requested to help in the selection of the best types of installations and later to carry on the complete projects which may enable us to build the plants, trusting that in a period not longer than three years the production in the mines will be doubled, with the hope that increased supply may keep pace with demand for coal and coke, which is increasing day by day in Mexico.

For their part, other companies such as that in Rosita are building new installations and enlarging those now in existence to enable them to produce larger tonnages.

We must confidently expect the crystallization of all these projects, as they form a very important part of the general industrialization now being carried on in Mexico.

PROBLEMS OF TEXAS-MEXICO TRADE

ED NUNNALLY

The Nunnally Exporters, San Angelo, Texas

A. Postwar Developments

It will probably surprise many people to learn that the 1947 trade between the United States and Mexico averaged around seventy million dollars per month. The growth of this trade since the war has been phenomenal and in proportion has far surpassed the expansion in the total trade of the United States. As Texas is the natural gateway into and from Mexico, the largest portion of this trade has passed through this state.

Among the factors responsible for this growth are these: enlarged purchasing power, growing populations, development of new industries, more demand for capital equipment and raw materials, additional power and transportation facilities, expanded public works programs, and pent-up demands for goods due to the war

One of the fundamental problems still confronting more trade is the need for basic essential information. We need an exchange not only of products, but of people as well—people of both nations visiting the other, examining their products, their economies, and their methods of doing business. Then their findings need to be made available to others, for neighbors as we are, neither knows too much of the other unless it be on the derisive and derogatory side.

More information is also needed on actual processing of shipments in foreign trade, with increased efforts toward simplification of existing rules and regulations. Our colleges and universities, for example, might well expand their instruction in the foreign trade fields since the need for qualified personnel is acute.

Our challenge, therefore, is one of knowledge and understanding—knowledge of the difficulties to be faced and a sympathetic understanding of their possible solutions, based in the last analysis on a kindly appreciation of one another as human beings and coupled with the sincere desire to be fair and just in international trade.

Foreign trade is with us, and it is a basic fundamental of our enlarging business life. It is also an instrument whereby our national policy is aimed and through which it may be carried out. We must realize, moreover, that world trade is a two-way street, filled with both imports and exports. Obviously, we cannot sell if our prospective customers have not sold us enough to get dollars which they can use to buy our own products.

1. *Values of trade.*

United States imports have not kept pace with its exports, for the latter are ten times as large as in 1938, and imports are only five times as large. In 1947 the United States exported $15.3 billion worth of goods and in

1948 $12.6 billion, which is 18 per cent less in value and 23 per cent less in volume. In 1947 this amount was 34 per cent of the world's total, and in 1948 it was 25 per cent of that total amount. Imports for 1947 were $5.7 billion, and in 1948 the amount was $7.1 billion, an increase of 23 per cent in value and 13 per cent in volume. The total 1947 trade was therefore $21 billion, followed by $19.7 billion in 1948. For the first two months of 1949, the figure was approximately $3.3 billion.

With respect to Mexico, the 1947 value of United States exports totaled $620 million, and imports were worth $246.7 million, or a total of $866.7 million. Our export balance was thus about $380 million. (See Tables 1-2-3, pages 89–90.) Mexico's share of United States trade was about 4 per cent in 1947, and this showed a significant increase from prewar figures. In comparison with Latin America, moreover, Mexico ranked first and third in 1946 and 1947, respectively, and held third place in both years as a source of United States imports. (See Table 7, page 91.) Mexico's trade is now 80 per cent with the United States, as compared to 67 per cent in the prewar years, and the United States is now supplying from 85 to 90 per cent of the Mexican imports, by value, and receiving 75 per cent of the Mexican exports. Composition of the trade itself shows no significant changes. Seeking to balance trade, however, Mexico forbade imports of certain non-essential items in July, 1947; increased her import tariffs in November and December, 1947, and, finally, on July 22, 1948, ceased to support the pegged exchange rate of 4.85 pesos to the dollar.

B. Essential Factors Involved In International Trade

1. *Basic economy of Mexico.*

a. *General economy.*

(1) *Agriculture*—Mexico's prime industry is agriculture, which is expanding rapidly due to increase of agricultural schools which provide technical training, expansion of the rural school system, an expanded reclamation program, and improved methods of marketing, both at home and abroad. The *Escuela Superior de Agricultura "Antonio Narro,"* located at Saltillo, Coahuila, is a splendid example of such an agricultural school and is under the able direction of Ing. Lorenzo Martínez Medina.

There is an increased tendency for Mexico to grow more crops for export, and 1948 was an unusually good year. (See Table 4, page 90.) Corn is the main crop and staple foodstuff. Following is a list of the principal 1948 crops, with production given in thousands of metric tons:

Corn	2,800	Tomatoes	238	Vegetable oils	98.0
Alfalfa	2,200	Beans	200	Coffee	55.4
Ref. sugar	600	Rice	150	Copra	35.0
Wheat	500	Chickpeas	119	Grapes	32.0
Meat	410	Pineapples	110	Lard	31.5
Oranges	350	Henequen	100	Flaxseed	22.0

Also included are 7½ million stems of bananas, the slaughter of 2 million head of hogs, and 550,000 bales of cotton.

(2) *Mining*—This aspect of Mexican economy has also been greatly developed. The principal mining area of Mexico consists of eleven states, which form an area roughly 1600 x 250 miles. This area extends from northwest in Sonora to southeast in Oaxaca and follows the Sierra Madre Cordillera. They include Chihuahua, Durango, Guanajuato, Hidalgo, Jalisco, Mexico, Michoacán, Oaxaca, Querétaro, Sonora, and Zacatecas. Mineral possibilities also exist in Baja California and Vera Cruz. Mineral production in 1948 was lower than the usual average, due to labor trouble, transportation, and federal taxes on industry. Available figures for 1948 indicate the following production, presented in metric tons unless otherwise indicated:

Coal	915,000
Copper	58,000
Gold	12
Iron	200,000
Lead	200,000
Oil	60,000,000 barrels
Silver	60,000,000 ounces
Zinc	140,000

Petroleum production was two million barrels over that of 1947, and Mexico enjoys seventh rank among oil producing areas of the world, supplying 3 per cent of its total production. Mexico's total mineral production in 1946 amounted to $169 million.

(3) *Manufacturing*—Mexican industrial developement has increased. The chief manufacturing industries include sugar mills, breweries, chemicals, paints, cigars and cigarettes, metals, and textiles. Mexico contains more than 13,000 plants, which represent investments of more than $215 million. Workers number nearly a half million, and the value of the industrial output approaches $300 million. Such expansion has been apparent mainly in consumer goods, not as much in heavy industry.

More than 35 per cent of the Mexican industrial production is found in the Federal District, and other important centers may be listed as follows:

Aguascalientes—railway machinery and equipment.
Guadalajara—iron and steel, textiles, shoes, soap, bricks, tile, pottery, and glassware.
León—shoes, clothing, textiles.
Monterrey—iron and steel, glass, beer, textiles, furniture, matches, chemicals, enamelware, paper products, lamps.
Puebla—textiles, railway equipment, cement tiles, ceramics.
San Luis Potosí—fiber products, leather, soap, flour, beer.
Saltillo—serapes, silver products, fibers, clothing.

(4) *Transportation*—The National Railways of Mexico is the most important system, with 9,000 miles of track, coverage of 22 out of the 28 states, and 76 per cent of the area of Mexico. There are an estimated 14,500 miles of track in Mexico, and during last year 18 Diesel locomotives were purchased, as well as some new shop equipment, and there was a limited amount of rehabilitation work. One new line was added: the Sonora and Baja California Railway which was finished in April, 1948.

Some 35 airlines flew over 20 million miles on 75,000 flights in 1948, with 225 airports and 1,050 landing fields available.

Road construction was fairly active in 1948. With about 45,000 miles of highways, 25 per cent are all-weather. Latest figures reveal that Mexico has 115,000 cars, 11,000 buses, and 53,000 trucks.

Seaports are ranked in the order of tonnage shipped during 1948 and include: Tampico, Veracruz, Puerto Mexico, Progreso, Manzanillo, and Mazatlán.

(5) *Communications*—Mexico has more than 400 telephone exchanges, with 235,000 telephones. There are nearly 700 telegraph offices, 250 long-wave broadcasting stations, 25 short-wave stations, and a combined newspaper and magazine circulation of over 300 million.

(6) *Financial*—Mexico faces a difficult foreign-exchange situation. After a seven-year period when the peso was rated at 4.85 to the dollar, it was unpegged on July 22, 1948. At the end of the year, the unofficial rate was about 6.50 to the dollar, and at the time of writing, the rate was between 8 and 9 pesos to the dollar. Such devaluation would be expected to offer better marketing opportunities for exports. With a substantial increase, it may be possible to gather a cushion of available exchange in excess of the required reserve to guarantee monetary circulation and sight deposits of the Central Bank.

About 10 per cent higher than that of 1948, the 1949 national budget totals about $385 million.

United States direct investments in Mexico are estimated at $425 million, while British holdings approximate $135 million.

(7) *Distribution factors*—Since the trend is toward modern distribution and merchandising methods, it will be well to consider the problem of locating the chief marketing centers as well as the areas which they serve.

Chihuahua—225 miles south of El Paso. It is a center of a silver mining and cattle region, and serves Chihuahua State.

Guadalajara—380 miles northwest of Mexico City. It is the second largest city of Mexico and the capital of Jalisco State. There are rail connections with Nogales, Mexico City, and the Pacific port of Manzanillo, with coverage of Jalisco, Colima, southern Zacatecas, and much of the Pacific coast north of Manzanillo.

Hermosillo—Agricultural and mining center covering most of Sonora and the southern part of Baja California.

Mazatlán—Covering Sinaloa and Nayarit. It is the largest seaport on the Mexican Pacific coast.

Mérida—Through Progreso. It is the distributing center for the Yucatán Peninsula and covers Yucatán, Campeche, and Quintana Roo.

Mexicali—Covers northern Baja California and western Sonora, with free entry privileges for agricultural implements, gasoline, machinery, and purchases made by residents across the border for their own use.

Mexico City—As the commercial, political, and industrial center, 68 per cent of all imports were consigned there and 19 per cent of the exports came from there in 1939–40. Nearly all large firms maintain their offices in Mexico City, and the Federal Government's purchasing offices are located in the capital city.

Monterrey—Third largest city of Mexico. It is the industrial center in the north and distributing center of Nuevo Laredo, Tamaulipas north of Victoria, and all but southwestern Coahuila.

San Luis Potosí—Covering San Luis Potosí State, Aguascalientes, and Guanajuato. It is a distributing center for mining and agricultural machinery as well as general merchandise.

Tampico—Is the center for the Gulf coast south to Tuxpán and northwest to foothills of the Sierra Madre. Most of the petroleum exports leave from this port.

Torreón—In the center of the Laguna District. It is the cotton producing area of Mexico and covers southwest Coahuila, eastern Durango and northwestern parts of Zacatecas.

Veracruz—Serves Veracruz State, southern Oaxaca, Chiapas, and Tabasco. It normally has more imports than any other port of entry, with direct connections to Mexico City by two railway lines, highways, and airlines.

(8) *Trade practices*—Credit usually varies; much business is done "cash against documents," but "cash with order" is usual if credit standings are not known. Credit from 30 to 90 days, however, may be extended if the firms are well established. Banks usually attend to the necessary details. Business usually halts from one to three or four o'clock, but firms stay open later. Business relationships are more informal and personal, and are complete with Latin courtesy and hospitality. Entertainment is found more in public places than in the home. Ninety per cent of the employees of a firm must be Mexican citizens unless qualified personnel is not available, and a minimum of 51 per cent of Mexican participation is required for enterprises in Mexico. This trend is aimed at discouraging foreign control of business enterprises. A similar law restricts practice of various professions except by Mexican citizens or by aliens meeting prescribed requisites.

2. *Texas and foreign trade.*

Since many of the most important economic enterprises in Texas produce goods of the kind that are exported to Mexico, it is natural that Texas should be interested in foreign trade. Such products include petroleum, raw cotton and cotton broad woven goods, meat and meat products, flour and other grain mill products and wheat, machinery, iron and steel products, lumber and wood products, sulphur, chemicals, tobacco manufactures, leather products, certain nonferrous metals, and autos and automobile equipment. (See Table 1, page 89 and Table 8, page 92.) Other Texas business firms that are affected include fruit and vegetable

processing, rice processing, shipbuilding, production of firebrick, cottonseed oil, cake, meal, and linters.

Texas imports include iron and steel, tin, nickel ore, chromite, castor beans, hemp, drugs and medicines, animal hides, and ores. The aggregate value of these products approaches $2 billion, while wages and salaries of these half a million persons employed is over $150 million.

Let's consider the products of the West Texas counties. With a total land area of 65,000 square miles, they have a total population of 960,000. In 1945 this area produced 14 million bushels of grain sorghums, 630,000 bales of cotton, 22½ million bushels of wheat, 1¼ million head of cattle, 110¼ million gallons of milk, 22 million pounds of wool, and 110 million barrels of petroleum. It is not out of order, either, to note that these counties produced more than either New Mexico, Colorado, or Arizona, taken separately. Texas, in short, is interested in world trade, and these figures do not include many new and large manufacturing establishments that have grown up in Texas since the war and whose products are in demand in Mexico and other parts of the world. (See Table 9, page 93.)

Total Texas foreign merchandise trade averaged $130 million per month in 1948, according to statistics compiled from the various customs districts. Exports averaged $110 million and imports made up the remainder. More specifically, the Sabine customs district averaged $14 million per month, Galveston about $78 million, Laredo $33 million, and El Paso $4½ million. Much of the water-borne trade, of course, was between Texas and Mexican ports, for with a total of $70 million worth of trade a month, more than half is directly over the border.

3. *Calculated factors in export-import practice.*

a. *Problems of exporting.*

To continue production and employment, Texas products must be sold, and to provide additional sales, we must seek markets abroad. Such a search involves these problems: Is it exportable? If so, where? What are the potentialities, habits, living conditions, manners, customs, and purchasing power of the country wherein such exports would be made? Let's consider, then, some of the problems that must be solved if there is to be successful exporting.

(1) *Evaluating product*—Is production sufficient for both domestic and foreign markets? Is there demand for the product? Can a demand be created? Is there anything that would reduce sales?

(2) *Foreign sales*—Is the product new, similar to one in use, made locally, or imported? With respect to new markets, what is their population, per capita income, purchasing power, trends, transportation, politics, habits, tastes, and distribution centers?

(3) *Government regulations*—What about tariff rules and regulations affecting the product, both domestic and foreign? How about government traders, monopolies, import and exchange controls, taxation, trade-mark

registration, tariff preferences, payments, industrial property rights, rules and regulations?

(4) *Competition*—Are similar products manufactured in the same distribution area? Who are local competitors and how strong are they? What is the competition from other countries? How do prices and terms compare with others?

(5) *Costs*—Since foreign markets are not interested in FOB factory prices, there must be consideration of trade-marks, packing licenses, transportation, fees, selling, insurance, discounts, terms of payment, commissions, and advertising.

(6) *Distribution*—What facilities are available? Where are they located? Is it better to establish an export department or use the services of an export agent, combination export manager, or export merchant?

(7) *Credit and exchange*—What about rates, availability of dollars, remission of funds, credit standings, and proper selection of agents?

(8) *Methods*—If the manufacturer can answer the above questions to his satisfaction, then he is ready to consider methods.

First, the factory may seek to export directly, using either a "built in" department, or setting up a separate export department. If the former procedure is introduced, increased business may later suggest the use of a separate department which can attend to all required functions.

Second, the services of an independent combination export manager may be used. This is an export sales manager who is in charge of his own business. He may serve as an export agent in selling products abroad and also have several factories using his firm as a means of developing export markets.

Third, the manufacturer may use an export house. Such a firm serves as middleman in that it buys merchandise for its own account and sells it overseas, serves on a commission basis, or acts as an export agent.

Fourth, a larger manufacturer may prefer to form his own subsidiary export company. This is simply a separate company of an organization, one dealing with domestic, the other with foreign sales.

b. *Potential machinery sales in Mexico.*

Now specifically, let us consider the potential market for machinery and equipment that could be exported to Mexico from Texas. The C.I.A.A., wherein the speaker formerly served as a political and economic analyst, has published information showing that Mexico, in the first ten-year postwar period, will require machinery valued at $635 million and that replacement of worn out equipment will require $351 million more. In this total of $986 million, $276 million would be for used machinery and $710 million would be for new machinery and equipment. A further breakdown reveals these figures:

Estimated Value of Equipment Needed

(Millions of Dollars)

	Used	New	Total
Transportation	144.1	369.7	513.8
Manufacturing	29.5	75.8	105.3
Power and Communications	30.2	77.8	108.0
Agriculture	24.8	63.6	88.4
Building and Construction	21.1	54.3	75.4
Lumbering, Woodworking, & Paper	8.9	23.0	31.9
Fishing	7.1	18.3	25.4
Mining and Petroleum	4.6	12.3	16.9
Scientific Apparatus	1.9	5.3	7.2
Consumer Goods	3.8	10.0	13.8
Total	276.0	710.1	986.1

Later figures reveal that this estimate is conservative, but it indicates the tremendous possibilities of finding markets for machinery and equipment in Mexico, provided the United States also buys from them.

c. *Problems of importing.*

Unless the United States imports from Mexico, that nation will not have the dollars with which to buy United States exports. (See Tables 1–4–7–8.) To help develop imports, the United States can study the revision of official exchange-rate parities, develop trade agreements, provide market surveys for the foreigner who wishes to export to the United States, hold trade sample fairs, and provide information as required.

In importing products, the importer must consider these problems: sources of supply, maintenance of quality, demand for the product, patents, and any features that might limit sales possibilities.

A study of the area in question will indicate whether or not such a product is being imported; if so, from where, and how much can be, and is being sold.

Government restrictions must also be studied. These include the problems of customs, consular invoices, import controls, food and health regulations, quarantine, markings of the country of origin, foreign laws and regulations, quotas, rationing, export-license systems, special taxes, and export duties.

As to competition, other firms may be importing the same article through agents, branches, distributors, or directly. A comparison of their methods and prices will be of value to the importer.

Checking the import cost will reveal if a better price can be obtained by paying for the goods abroad. If so, this may be made by bank drafts or import credits or a domestic letter of credit. Also to be considered are documentation fees, insurance, and commissions.

With respect to distribution, either direct or indirect methods may be used. This involves the use of a company import department, on the one hand, or the use of an import merchant, commission house, resident agent, wholesaler, or jobber.

Finally, the human element presents a major problem for analysis. Such dealer or representative must be considered from the point of view of reputation, standing, facilities, training, experience, and credit.

4. *Problem of financing trade.*

a. *Exports.*

One of the most important problems is that of financing trade, whose terms depend, of course, on the credit standing of the buyer. With Mexican trade, there may be some open account business with reliable, established connections, or various forms of drafts, depending on the pertinent situation at hand. The following various methods are considered briefly:

Open account—shipment is made minus any payment instruments, and the purchaser remits from time to time as agreed.

Consignment—goods are shipped subject to sale on prices and terms to be agreed upon.

Bank guaranty—statement issued by the importer's bank which guarantees payment of drafts that are drawn in compliance with certain stipulations.

Letter of credit—According to Wilbert Ward, in *American Commercial Credits,* a commercial letter of credit is "a written instrument issued by the buyer's bank, authorizing the seller to draw in accordance with certain terms, and stipulating in legal form that all such bills will be honored." If they are circular letters of credit, that is, addressed to persons in general, they may be mailed to the exporter either by the importer's bank or by the importer himself. If the bank transmits this letter to the exporter through its correspondent bank in the latter's country, then it is termed "especially advised." If the bank reserves the right to withdraw from the transaction at a later date, the letter is known as "revocable." But if the credit includes an express waiver of the right to cancel or revoke the credit prior to a specified date, it is regarded as "irrevocable." Such credit is "unconfirmed" if the notifying bank assumes no obligation in sending to the exporter the information that such credit has been opened in his favor, but if it does so, the credit is "confirmed." Therefore, a confirmed irrevocable letter of credit offers the most security, for such credit will not be withdrawn and the drafts will be honored by the bank as long as it remains open.

b. *Imports.*

If paid for abroad, the importer may often buy goods at better prices. Various methods may be used:

Import credit application—Set up with the United States bank in favor of the foreign seller. The latter then attaches various papers as designated to the bank in his country through which he received the notice of the credit opened, and receives payment.

Import letter of credit—Considered above in relation to export letters of credit, it follows a similar procedure.

Sight and time credits—If a bank accepts a foreign seller's draft under an import letter of credit, it at once advises the importer. If such credit is on a sight basis, D/P, documents against payment, the importer pays the amount in cash before he takes possession of the goods. If the credit is on a time basis, payment may be made as goods are sold.

Straight drafts—Foreign seller may draw at sight or so many days after date, with documents carrying title to the goods released either against payment of the draft (D/P), or against acceptance (D/A).

C. PREPARATION OF SHIPMENTS TO MEXICO

After our discussion of the postwar developments, Mexico's basic economy, Texas' part in trade, factors involved in exporting and importing, plus the problem of financing such trade, let us now assume we agree there are wonderful possibilities and we are anxious to begin exporting. Here again, there are many problems to be considered.

1. *Documents required.*

Mexican law requires:

(1) *Commercial invoice*—Seven copies are needed on all shipments, whether by land or water. They should be sent by the shipper to his customs broker (services of such broker are required by law) or to the consignee in Mexico for use in clearing customs. Spanish is preferable, and these should contain the place of and date on which sale is made (on the original); name of final consignee and his broker; marks, kind, quantities, and total number of packages; commercial description of the goods; and signature of the seller.

(2) *Bill of lading*—Must show the marks, serial numbers, quantity and and kinds of packages, and weights, preferably in units of the metric system. It requires no consular legalization. As shipments may be made either on a through bill of lading or on a local bill of lading to the border, the purchaser's wishes should be determined. If on a through bill of lading, the original should be sent directly to the consignee and a signed copy marked "for customhouse purposes only" is to be furnished the forwarding agent or broker at the border. These services are legally obligatory at the point of entry.

(3) *Packing list*—While not required by law, most customs brokers require such a list, which is furnished in triplicate. It shows the gross, tare, and legal weights of each package, total number of packages, and the gross, tare, and legal weights of the entire shipment. Accurate weights are required, otherwise there may be fines.

(4) *Consular manifest*—On overland shipments, this document is made in triplicate and legalized by the Mexican consul nearest the customs house of entry. It is prepared and signed by the broker.

(5) *Shipper's export declaration*—Required by the United States, this document is made in quintuplicate for air shipments and in duplicate for shipments by rail, car, vehicle, vessel, and ferry. Only a single copy is required for postal shipments. Verification by oath is required for shipments by vessel to foreign ports, but such oath is not required for postal, rail, aircraft, vehicle, or ferry routes.

(6) *Sanitary certificates*—These must be presented in quadruplicate on shipments of livestock, animal products, seeds, plants, and plant products, and are issued by appropriate health authorities of the State or municipality or by the United States Department of Agriculture.

(7) *Air-express shipments*—Preparation is similar to that used for ordinary express packages. Heavy packing is not necessary. Such goods usually receive preferred customs clearance, and five copies of the Shipper's Export Declaration are required. The sender furnishes full descriptions of the goods and their value, signs the airway bill, and the company performs the remaining functions.

2. *Labeling-packing-marking.*

Labeling—Since the metric system is the only system legalized for Mexico, all labels at the time of the sale must show net weight or contents in metric units, and all references to units of other systems must be removed. This does not yet apply to labeling of merchandise at time of import.

Packing—Exporters should follow their customer's instructions carefully as to packing, marking, and routing of shipments. Since more of the goods imported are dutiable by weight, figures must be accurate. Weights are defined in this manner: legal weight: weight of the merchandise, together with usual wrapper inside the outer packing case; net weight: actual weight of merchandise without wrappings or containers; gross weight: weight of merchandise plus weight of all wrappings and containers.

Marking—Either brush or stencil can be used for marking. All weights should be given in kilograms or factors or multiples. All markings should conform exactly to those listed in the consular manifest, and all other markings should be removed.

3. *Shipping by mail.*

Parcel post packages weighing as much as 44 pounds may be sent through the mail. They may be registered, must be sealed, and cannot be insured. The wrapper should indicate if the parcel contains dutiable merchandise, or it should state that it may be opened for customs inspection at destination. Otherwise, a fine of double the import duties may be imposed. Commercial invoices are provided in quadruplicate, as well as a customs declaration tag, which is Postal Form 2966. A surtax of 10 per cent of the regular duty is also assessed.

Dutiable articles may also be sent in letter mail, if the prescribed form of green label, Postal Form 2976 is attached, as well as a customs declaration or a commercial invoice. The letter rate is 3 cents an ounce or fraction, with a weight limit of 4 pounds, 6 ounces. Such mail should state it can be opened for customs inspection.

4. *Advertising matter and samples.*

Advertising matter, even single catalogues, is subject to duty when sent by mail or by any other means. Since these duties cannot be prepaid, the services of a United States freight forwarder may be used, with costs borne by the exporter; or a postal money order may be sent the consignee to cover the cost of clearing the parcel. Advertising matter in small shipments may be sent by regular mail as "prints" to avoid the surtax collected on parcel-post packages. In general, printed matter may weigh up to 22 pounds, while single volume weight is not limited.

Samples of no commercial value are admitted free of duty, but if usable or salable, duty is assessed. To avoid duty, otherwise marketable goods should be perforated or mutilated to thus become unusable. Small amounts of foods, beverages, volatile or fixed oils, fats, greases, waxes, fibers, perfumery, cosmetics, aromatic waters, soaps, drugs and similar products, also odd pieces of jewelry are not given duty-free entry as samples, but are assessed regular duty. If the sample has no commercial value and weighs up to 18 ounces, it may proceed by sample post.

5. *Entry and warehousing.*

Within ten days after unloading, merchandise either must be declared for warehousing or for customs clearance. Goods must then be cleared and withdrawn within one month after unloading, or storage fees accrue. If not claimed within six months, the goods are considered abandoned and may be sold at auction. Goods may also remain in the warehouse for one year, and prior to expiration of that period, such goods may be re-exported free of import duty or withdrawn for clearance for consumption on payment of fees, duties, and other charges.

6. *Import license and exchange rules.*

Some import items have been subject to control by the Law of April 15, 1944, and some export items have been under similar control by Presidential decree of June 15, 1944. Another decree of July 11, 1947, temporarily suspended any importation, except as licensed, of a number of items, and also imposed higher tariff rates on others. Additional articles were added to the control lists on February 11, 1948, and on September 3 and November 12, 1948, the former lists of licensed imports was revised and amended. It now includes about 135 tariff items, subject to prior license, and includes goods under United States export control. All products not included in this list are free from licensing requrements. Import permits, which must be obtained prior to clearance of goods through the customs are usually valid for a period of 90 days. Barter

and private compensation transactions are not subject to control in Mexico.

With respect to the import tariff system, a decree of November 13, 1947, required most products to be assessed an *ad valorem* duty in addition to specific duties. Its basis is a percentage of the value of the merchandise as stated in the commercial invoice, which is defined as market price in the country of purchase plus any charges except freight and insurance. There is also a customs surtax of 3 per cent on all importation by freight or express, and a mercantile income tax, ranging up to 3.3 per cent, which is assessed on income from sales of virtually all merchandise.

7. *Industrial property protection.*

In Mexico, individual or juridicial persons, either foreigners or nationals, may register and thus obtain exclusive right to the use of their trade-marks. The first registrant is entitled to the exclusive use of a mark, subject to those who have used similar marks for three years, and to the priority granted foreigners. Such registration is made for 20 years, counting from the date of application and since merchandise is divided into 50 groups, the application must indicate the goods for a single registration will not include goods in other categories.

Applications are to be filed in the Department of Industrial Property, Office of the Department of Industry, Commerce, and Labor.

8. *Passport regulations.*

If on a pleasure trip, a United States citizen needs no passport or visa, merely a tourist card, available at any Mexican Consulate, good for six months, and costing $1.50. Naturalized citizens must carry proper papers. A business trip requires a "visitor's card," as well as a passport, and procedure is more complicated.

D. Proposals For Improving Trade Relations

1. *Educational.*

The people of Texas and Mexico need to know one another better. As it is, Mexicans see far too many *Norteamericanos* visiting them for the only apparent purpose of becoming intoxicated and creating disturbances. On the other hand, too many *Norteamericanos* seem to believe that the only people to be found in Mexico are the *braceros*. Neither belief is correct. Following the Del Rio sessions of the Texas Good Neighbor Commission on May 6, 1949, a group of some twenty Texans were invited to Saltillo, Coahuila, by Governor Rául López Sánchez. Several of our group were amazed at their discoveries, for they learned many new ideas, and were guests of courteous, dignified, friendly, co-operative, gentlemanly, and sympathetic officials and people of Mexico. An increased interchange of such groups is most essential, for each can and will learn much from one another. That's education.

Accelerated exchange of teachers and students is another factor, for both summer and regular long-term sessions. Such advantages are obvious, and even he who runs may see them.

Whereas the study of English is obligatory in Mexico, the decline of Spanish instruction in Texas is most disturbing. Official emphasis upon more "practical" courses in our schools fails to realize or to appreciate the significance of expanding trade between Texas and Mexico. Such trade, valued at more than $2 million per day, can be increased as people become more aware of the boundless opportunities. A greatly expanded program of Spanish instruction in Texas is essential, and this point is one of the aims of the Latin-American Commission of the West Texas Chamber of Commerce as well as other organizations.

2. *Travel.*

The value of tourist travel is increasing. Tourists spend money, and, when treated with courtesy, they will become friends. Both Texas and Mexico know this fact. Internationalization of the Big Bend Park, for example, will be an added tourist attraction for all peoples, and through such travel there will be still more interchange not only of products, but of people as well.

3. *Creation of consulates.*

The wisdom of our two governments in establishing consulates has long been borne out by the results. At such offices, peoples of both nations can secure cultural and commercial information, which is of value to all concerned. One of the most recent consulates to be created in Texas was the Mexican consulate at San Angelo, where Señor Juan Richer and Professor Ismael Corzo are able representatives of their country. Our own country, also, may wish to consider the advisability of re-opening the United States consulate at Saltillo, Coahuila, which is a growing center of international trade in areas still not too widely tapped.

4. *Improved transportation.*

There could be no foreign commerce without transportation. Texas and Mexico need more gateways, by land, sea, and air. When these appear, the results will be found in increased trade and traffic, to the mutual benefit of both entities.

(1) *Rail*—Officials of the Mexican Government have announced plans to extend the Mexican National Railway lines from San Carlos to Villa Acuña, a distance of 24 miles. If, on the Texas side, Santa Re Railway officials will extend their lines from Sonora to Del Rio, a distance of 90 miles, the resulting connection will create a direct line from Mexico City to Chicago, via West Texas, thus opening up even greater opportunities in trade and commerce. This project enjoys top priority among the aims of the Latin-American Commission of the West Texas Chamber of Commerce.

Mexican railway officials have cited figures showing that yearly carloads between Mexico and Texas amount to 100,000 cars. Development of this proposed railway extension would divert ⅓ of such carloadings into West Texas, as well as increase trade in general. If such diversion would bring 3,000 carloadings per month through West Texas as well as $20 million in value, the results speak for themselves.

(2) *Air*—An air port of entry for West Texas is also desirable to facilitate the flow of goods in areas not now covered. Aside from El Paso and Laredo, a vast area remains in between where improved air transportation between Mexico and Texas could be expanded.

(3) *Highway*—Improved highways are a necessity, and can aid in the development of tourist as well as other commercial traffic. Along with highways, bridges are in demand. A free international bridge at Del Rio, for example, could connect with Villa Acuña, and highways from that city down to Allende would open up still more areas for trade purposes. Here again are more opportunities.

5. *Trade sample fairs.*

Too few people in either Texas or Mexico are acquainted with the products of the other. So let's invite the people of Mexico to come to Texas and bring samples of their products with them—all kinds of products, and let's hold a fair, where these products can be displayed, and where prospective customers can enter orders on the spot. People who come from Mexico will not only educate us, but they will be educated, they will travel, make use of consular facilities, use modern methods of transportation, and have a chance to practice their English. Texans invited to trade sample fairs in Mexico, too, will have an opportunity there to do the same things as the Mexicans here. Such an interchange of peoples and products would bring home to each of us the importance and the problems of Texas-Mexico trade, and they would be approached with renewed vigor and determination.

6. *El porvenir es bueno.*

We can well agree that international trade and our free private enterprise system cannot expand until more people receive their benefits. Is it not possible, then, to seek an improved understanding that manifests itself with less uneconomical protectionism, anti-foreign legislation, and government regimentation? Development of human and natural resources requires more manpower, technological skill, and experience, and the use of capital on a large scale. It is realized that there are differences in the basic economic policies, particularly with respect to the role of the state in economic life. But economic development plans must produce better standards of living. If not, it can be expected that social troubles will increase and political instability will threaten the future of international trade.

If the problems of Texas-Mexico trade are to be resolved with more knowledge and understanding, then we can agree upon the need of sound investment policies, business and economic stability, and the encouragement of international trade on a basis of what is fair, what is right, and what is just—for everyone concerned.

TABLE 1

UNITED STATES-MEXICAN TRADE IN COMMODITIES

(Value in millions of U.S. Dollars)

Mexican Imports	Value 1938	Value 1947	Percent of Total 1938	Percent of Total 1947	1938 Percent Mexico Takes or Supplies	1947 Percent Mexico Takes or Supplies
Machinery	12.6	165.9	21.2	26.8	2.6	7.1
Autos, Parts, Access.	6.5	84.1	10.9	13.6	2.4	7.3
Foodstuffs	6.5	64.6	10.9	10.4	1.5	2.1
Chemicals and Products	5.1	46.7	8.6	7.5	4.0	5.5
Iron and St. Mill Prods.	4.8	45.1	8.1	7.3	2.6	5.5
Textile Manufacturers	2.3	32.2	3.9	5.2	.7	1.7
Petroleum and Products	3.8	23.0	6.4	3.7	1.0	3.6
Iron and St. Adv. Mftrs.	2.5	22.3	4.2	3.6	5.8	8.4
Paper and Products	1.1	10.6	1.8	1.7	4.2	7.4
Mexican Exports						
Foodstuffs	17.7	73.6	41.6	30.9	3.1	4.5
Nonferr. Metals and Mfrs.	7.9	66.8	18.6	27.1	7.0	15.1
Petroleum Products	2.4	20.0	5.6	8.1	6.1	7.7
Sisal and Henequen	4.0	16.0	9.4	6.5	41.7	50.8
Sawmill Products	.1	11.2	.2	4.5	.7	11.1
Crude Chicle	1.5	7.4	3.5	3.0	60.0	62.7
Unman. Cotton	2.3	3.9	5.4	1.6	24.0	7.0
Leather Products	.3	1.3	.7	.5	3.6	11.2
Cotton Cloth	.....	1.0	.....	.4	.....	13.2

TABLE 2

UNITED STATES-MEXICAN MERCHANDISE TRADE

(Percentage of Total)

	Exports to Mexico	Imports from Mexico	Excess of Exports (+) or Imports (—) (Millions of Dollars)
1911–15	1.8	4.4	— 30.7
1916–20	1.8	4.1	— 23.9
1921–25	3.3	4.3	— 1.1
1926–30	2.6	3.1	— 3.9
1931–35	2.4	2.3	+ 9.5
1936–40	2.7	2.3	+ 27.5
1941–45	2.1	4.8	+ 43.3
[illegible]	5.0	4.7	+271.9
1947	4.1	4.3	+383.2

TABLE 3

UNITED STATES-MEXICAN MONTHLY TRADE

(In Millions of Dollars)

	Exports to Mexico					Imports from Mexico				
	1937	1938	1946	1947	1948	1937	1938	1946	1947	1948
Jan.	7.0	8.0	31.7	51.0	44.2	5.0	4.1	21.4	25.0	19.5
Feb.	7.8	7.0	31.5	50.4	37.1	5.5	4.2	17.1	21.2	25.3
Mar.	9.4	6.1	37.9	62.5	45.5	6.9	5.0	19.9	23.3	27.2
Apr.	10.6	3.9	33.9	57.0	47.1	7.0	5.8	25.6	22.2	24.2
May	8.8	4.0	39.2	56.9	45.8	5.1	4.1	16.9	17.4	17.5
June	9.9	4.9	42.4	46.8	46.4	5.6	4.2	16.1	21.5	17.0
July	11.0	3.6	38.2	51.7	46.8	4.4	4.6	20.2	18.3	18.8
Aug.	9.0	4.1	44.4	44.8	37.4	4.7	3.2	18.3	16.7	17.4
Sept.	9.1	4.4	45.7	43.3	36.4	3.9	2.4	14.9	21.7	17.2
Oct.	8.4	4.5	51.5	52.9	.....	3.6	3.1	18.1	19.2	.....
Nov.	8.3	5.2	50.3	52.2	.....	3.9	3.0	20.1	15.7	.....
Dec.	9.5	5.8	57.5	60.0	.....	3.9	4.6	23.4	23.8	.....

TABLE 4

UNITED STATES IMPORTS FROM MEXICO FOR CONSUMPTION OF MERCHANDISE, 1948

(Millions of Dollars)

Lead and manufactures	39.000
Vegetables and preparations	25.716
Copper and manufactures	23.678
Vegetables fibers and manufactures	20.306
Cocoa, coffee, tea	17.455
Shellfish and products	12.301
Sawmill products	11.933
Petroleum and products	10.494
Fruits and preparations	9.202
Zinc and manufactures	8.486
Sugar and related products	7.152
Naval stores, gums and resins	4.760
Spices	3.880
Nonferrous ores, metals	3.849
Oil seeds	2.918
Unmanufactured cotton	2.774
Drugs, herbs, roots	2.604
Fodders and feeds	2.171
Vegetables oils and waxes	1.407
Fish and fish products	1.312
Clay and products	1.304
Ferro alloys ores and metals	1.014
Miscellaneous	6.401

TABLE 5

UNITED STATES TRADE WITH REST OF WORLD, BY CONTINENTS

(Percentage of Total)

	U.S. Exports To			U.S. Imports From		
Continent	1938	1946	1947	1938	1946	1947
North America	51.7	67.2	76.0	37.9	44.0	45.0
South America	26.4	50.3	59.5	20.6	32.0	29.9
Europe	10.7	26.3	23.4	6.2	7.9	5.9
Asia	16.1	39.0	37.9	26.4	25.7	21.3
Oceania	13.6	24.0	19.2	2.8	15.7	12.6
Africa	10.2	20.4	22.7	3.4	9.6	11.8
World	14.9	33.8	33.9	13.2	19.8	17.3

TABLE 6

TRADE DISTRIBUTION OF LATIN-AMERICAN REPUBLICS

(By Percentage)

	Imports From			Exports To		
	1936–38	1940–44	1947	1936–38	1940–44	1947
United States	33	57	63	32	52	39
Latin America	10	21	11	6	13	11
Others	57	22	26	62	35	50

TABLE 7

UNITED STATES TRADE WITH LATIN-AMERICAN REPUBLICS

(Percentage of Total Trade)

	Imports from United States			Exports to United States		
	1938	1946	1947	1938	1946	1947
Argentina	17.4	28.5	45.5	8.5	15.0	9.9
Brazil	24.2	58.2	61.3	34.3	42.2	38.8
Chile	27.8	40.3	43.7	15.7	36.6	44.5
Colombia	49.9	68.8	71.6	52.7	81.9	84.6
Cuba	70.9	76.3	84.0	75.9	67.4	66.7
Mexico	57.7	83.6	88.4	67.4	73.0	77.0
Peru	34.3	56.2	58.3	26.8	25.4	29.3
Uruguay	11.7	32.7	38.3	4.0	29.8	28.6
Venezuela	56.4	75.7	.....	13.2	30.9	.....
Central America	51.9	72.2	.....	67.3	78.2	.....
Others	34.1	51.9	.....	19.5	39.4	.....

TABLE 8

UNITED STATES FOREIGN TRADE, 1948

Exports

(Millions of Dollars)

Machinery	2,253	(Increased over '47; industrial off 7%)
Wheat and Flour	1,394	(Increased over '47)
Cars (Parts and Acc.)	905	(Off 20% from '47)
Textiles and Manufactures	844	(Dropped 40%)
Chemicals and Products	758	(Dropped 8%)
Petroleum and Products	657	(Same value, motor fuel off 25% in quantity)
Iron and Steel Mill Products	650	(Dropped 33%, but above pre-war)
Unmanufactured Cotton	511	(Increased, but low compared to pre-war)
Coal and Related Fuels	492	(Declined 33%)
Merchant Vessels	256	(Dropped 60%)

These above products represented 69% of U.S. 1948 trade. Total value was $12.6 billion, 18% less than 1947 in terms of index numbers. Was 112% more in quantity than 1936–38, but 23% less quantity than 1947. Meats, fats, dairy products and eggs less in 1947–48, and tobacco off sharply.

Distribution of Exports on Percentage Basis

Europe	35.0	(42% in 1936–38 and 1946; 38% in 1947)
W. Hemisphere	25.2	(Becomes progressively more important)
Canada	15.2	
Far East	15.0	(Took 19% in 1936–38)
E. Hemisphere	8.3	(Took less)
E. Europe	1.3	(Took 3.7% in pre-war period)

(ERP countries took 38.1% in pre-war, 33.2% in 1948)

Imports

(Millions of Dollars)

Paper and Materials	753
Nonferrous Ores and Metals	736
Coffee	698
Petroleum and Products	418
Sugar	313
Crude Rubber	309
Unmanufactured Wool	308
Vegetable Oils and Seeds	234
Fruits, Nuts, Vegetables	222
Cocoa	194

Crude Materials	30.0%
Foodstuffs	28.5%
Semi-manufactures	23.2%
Finished Manufactures	18.3%

Total value was $7,070 billion, 23% over 1947 in value, 13% over value by index number, and 23% over 1936–38 average by index number. These products represented 59% of total imports.

Sources of Imports

(Percentage)

W. Hemisphere	58.0	(64–75% in 1942–45, 56% in 1946, 59% in 1947)
Far East	18.8	(Supplied 27–30% between the two wars)
Europe	16.0	(50% before 1st W.W., 7–8% during war, 30% between wars)
ERP Nations	13.5	(Supplied 24% in 1936–38)
Africa and Near East	7.4	(Furnished 3.3% in 1936–38)
Eastern Europe	2.1	(Totaled 4.1% during 1936–38)

TABLE 9

RESOURCES OF SPECIFIED WEST TEXAS COUNTIES

Bailey	Fisher	Jones	Reeves
Bosque	Floyd	Knox	Roberts
Brewster	Foard	Lamb	Runnels
Brown	Gaines	Lipscomb	Schleicher
Carson	Garza	Lubbock	Scurry
Cochran	Gray	Lynn	Sherman
Coke	Hale	Moore	Sutton
Coleman	Hansford	Nolan	Swisher
Cooke	Hardeman	Ochiltree	Tarrant
Crane	Haskell	Parmer	Taylor
Crosby	Hemphill	Pecos	Terry
Dawson	Hockley	Potter	Tom Green
Deaf Smith	Irion	Randall	Upton
Erath	Johnson	Reagan	Wheeler

General Economy

Area in square miles	65,373	Virgin tillable land, acres	3,213,219
Total population	962,160	Cattle on farms	1,222,334
Bales of cotton	631,766	Wool shorn, pounds	22,037,447
Bushels grain sorghum	14,213,734	Mohair clipped, pounds	1,900,860
Tons sorghum silage	1,815,169	Milk produced, gals.	110,215,389
Bushels winter wheat	22,486,104	Oil, 1945, bbls.	109,895,082

Comparison of Resources

(In 1,000's of Units)

	56 West Texas Counties	State of New Mexico	State of Colorado	State of Arizona
Grain sorghums, bu.	14,213	2,218	1,160	820
Cotton, bales	631	128	None	195
Wheat, bushels	22,486	2,305	14,084	890
Cattle, head	1,222	843	1,144	638
Milk gallons	110,215	29,372	100,536	24,393
Wool, pounds	22,037	15,451	13,406	4,505
Oil, barrels	109,895	38,411	2,320	None

(Information used came from brochure compiled by Joe James of the West Texas Chamber of Commerce headquarters in Abilene, Texas. Basic material from the Texas Almanac and the Statistical Abstract of the United States.)

BRIEF SKETCH OF THE INDUSTRIAL DEVELOPMENT OF MONTERREY

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Anyone who undertakes a study of the origin, the founding, the growth, and development of the City of Monterrey will encounter as ever present factors the ambitious purpose of its founders and its inhabitants to carry out a great enterprise and aspire to great things on the one hand and, on the other, the difficulties, which had to be overcome during its entire history, at times almost insuperable. High purpose, almost insurmountable barriers, tenacity, and the acceptance of the constant effort have gone to make up the character and the way of life of the inhabitants of this city.

In the year 1567 a young man, 27 years of age, came to America for the purpose of dedicating himself to the breeding and raising of cattle along the Gulf Coast near Pánuco and Tampico, but in his desire to acquire a name for himself and achieve renown, he made several explorations inland and soon became the head of expeditions which attracted the attention of the viceroy. This young man was named Luis de Carvajal y de la Cueva. He went to the City of Mexico and from there to Spain, where on the 14th of June, 1579, he entered into agreement with King Philip II which authorized and empowered him to discover, pacify, and settle a region to be known as the New Kingdom of León and of which Carvajal y de la Cueva would be Governor General for life. The explorer was not backward in his dealing with the King of Spain. The new kingdom which he proposed to establish was to be assigned the territory comprised within a square eight hundred and thirty-eight kilometers (approximately 500 miles) on each side, measured to the north and west from the mouth of the Pánuco River, 702,000 Km^2 (250,000 square miles) or a little more than one-third of the actual area of the present Mexican Republic. On the west it would extend to the Pacific Ocean and on the north would include a part of Texas. He returned to America in a ship of his own to carry out his enterprise.

After founding the city of León, now known as Cerralvo, where valuable minerals had been discovered, he continued into the interior and came upon a fertile valley, surrounded by mountains and watered by fresh water springs. He decided to found another city there and did so after visiting Saltillo. In the year 1581, on the north bank of the fresh water spring known as Santa Lucía, whose waters can still be seen running through present Monterrey, Don Luis Carvajal y de la Cueva with a few of his followers founded the village of San Luis.

This town lasted but a few years. Very shortly the small number of its inhabitants had to abandon it and return to Saltillo. The head of the undertaking was lodged in jail and later sent to Mexico City because

of difficulties arising from jurisdictional jealousy between him and the previous authorities, complicated by charges of being a Judaicer. Life was extremely difficult. The Indians of the region, who were nomads and hunters, constantly attacked the little group to avenge the cruelty of the soldiers of the conquest. Up to this time, unfortunately, the protecting hand of the missionaries had not reached these regions. However, a few years later, Don Diego de Montemayor, who had been appointed Lieutenant Governor and Captain General of the New Kingdom of León and who had taken up his residence in Saltillo, abandoned his Saltillo residence and with twelve of his followers and their families returned to the banks of the Santa Lucía and the superb scenery of the peaks of the Sierra Madre to the south, the Cerro de la Mitra to the west, and the Saddle Mountain to the east. On the 20th of September, 1596, with all due solemnity, as set forth in the official record, the "Metropolitan City of Our Lady of Monterrey" was founded with all the rights and privileges granted to metropolitan cities by royal decree. Its city council and other authorities were then appointed. The name of Monterrey was used to honor Don Gaspar de Zúñiga y Acevedo, Count of Monterrey, who was at the time Viceroy of New Spain.

Carvajal's dreams of a great kingdom terminated with his imprisonment and death. Diego de Montemayor's dreams of a great metropolis, founded with insufficient inhabitants to fill all posts in the city council, was the humble beginning of the City of Monterrey.[1]

The pretentious metropolis of Monterrey was barely sixteen years old when all of its buildings, mostly constructed of adobe, straw, and palm leaves, were destroyed by a flood. Its inhabitants rebuilt the city, but this time on higher ground about 400 yards distant from the original site.

When it was forty years old, in 1636, another flood washed it away again. Torrential rains that lasted more than fifteen consecutive days caused the Santa Catarina River, the Santa Lucía Springs, and a dry creek bed in the center of the city to overflow. Not a single house was left standing; even the convent and the church were destroyed. Again the inhabitants reconstructed their city.

As late as 1752, that is, 156 years after its founding, another storm destroyed the city almost in its entirety, but again the inhabitants and the government rebuilt it.

The historian, Don José P. Saldaña,[2] says:

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[1]Six years later, but eighteen years before the landing of the Pilgrims, Sebastián Vizcaino, who had been exploring the coasts of California, landed in the bay of Los Pinos, at a point which he had named Monte-Rey in honor of the same viceroy who governed up to the year 1603. The name of both cities is the same since they derive from the same source. The fact that the capital of Nuevo León is spelled with two r's is due soley to a rule in Spanish grammar, which naturally is not applicable to the city in California.

[2]*History and Traditions of Monterrey*, 1943, p. 101.

Difficult was the task of the first founders. Scarcity of everything necessary, continuous attacks, insecurity of both life and property, tended many times to leave authority in the hands of a single person, since it was not possible to find suitable individuals to make up a city council.

But nothing dismayed the colonists. Their strong character and perseverance overcame all of the calamities which beset them. Some fell by the wayside, but others took their places and the light of their faith receded into the distance like remote stars.

Out of perseverance, faith, incessant labor, sacrifice, privations, valor, fortitude were forged the foundations of Monterrey. Hard as a rock but generous as befits a child of sorrows.

The tenacity of these people, that of their children and their children's children to remain in a place so poorly blessed by nature and not to abandon it to seek some other place where life would be easier is indeed worthy of note. The region has no fertile lands for abundant cultivation; neither are there good grazing lands for cattle. It has no rich mines, except for a few small ones now almost exhausted. The climate, although healthy, is rigorous, cold, and wet during the winter and very hot during the summer. Its distance from the capital of the country and from the rich farming and grazing lands and mines in the south and the great desert that lies between, which must be crossed to reach them, undoubtedly was the cause which prevented this zone in the north from feeling, except in a very small way, the generous impulse of constructive colonization which the colonial period imparted to the central and southern parts of the country. It is for this reason that colonial buildings are not found in Monterrey, nor are the marvelous churches, hospitals, libraries, monuments, and paintings to be seen, which marked the passage of Spain through the New World and which we are still able to admire in the central and southern parts of the republic. It is for the same reason, no doubt, that the indigenous tribes of the north had not achieved any appreciable advance in civilization by the time the Spaniards arrived in their section of the country; neither are there any visible signs of their achievements.

The first two hundred and fourteen years of Monterrey's life to the start of the movement for independence were characterized by a constant struggle to eke out a bare existence. During this time it served as a base for expeditions organized locally or that came from Mexico City to explore and colonize the new lands or as a bulwark of defense against the attacks of Indians who came down from the nearby mountains. Its growth was very slow. In 1626, thirty years after it was founded, Monterrey did not have one hundred inhabitants. In 1775, the number had increased to 258; and in 1803, its population numbered 6,412.

During the first fifty years of independent life, Monterrey, like the rest of the country, was affected by the necessary adjustment to the new regime of self government, aggravated by two foreign wars. Nevertheless, in January, 1856, taking advantage of a nearby waterfall, it inaugurated its first cotton textile factory, which was organized by Monterrey men with local capital. This factory was propelled by enormous water

wheels 8 to 10 meters (24 to 30 feet) in diameter, which were manufactured in England, delivered through the port of Matamoros, or Bagdad as it was known at that time, and brought to Monterrey overland in ox-carts.

During the period of the war in the United States between the North and South, the navy of the Union blockaded all the southern Gulf ports, and all the export and import trade of the Confederacy was carried on across northern Mexico. Monterrey found itself in a strategic position. Its men were never known to shun profitable enterprises because of dangers. Many took advantage of the opportunities this traffic presented. Wagon trains were used to transport cotton to shipping points; and since the Southern States needed manufactured articles which they could not produce, there were imported from Europe and delivered for sale at high prices in New Orleans and Atlanta. There was no lack of daring spirits who made large fortunes smuggling powder and war materials to the Confederates. These were exchanged under most favorable conditions for useless cotton piled up in the warehouses of the South as a result of the effective Northern blockade, which had reduced by 95 per cent the export to England of this fiber, the principal article of trade of the agricultural South. It is said that there was so much gold in Nuevo León at the time that it was exchanged at a discount for circulating silver coins. When the war ended and the facility to make large profits terminated also, the organizations which had been built up, the transportation systems, the routes and stations of the freighters, commercial contacts in the country and abroad remained in the hands of the enterprising men of Monterrey. Thus was the transportation business and commercial relations made permanent. There was no lack of difficulties in the new business. The roads were bad, dangerous, and risky. Holdups were frequent both by Indians and by bandits. An efficient organization and scrupulous honesty were required to deliver faithfully the merchandise and money entrusted to freighters. Profits were large. This gave to Monterreyites the opportunity to exercise their characteristic virtues while maintaining a tradition which is still carefully treasured and constitutes the pride of the inhabitants of Monterrey.

The habit of handling cotton and the success of the La Fama textile mill, established in 1856, due to the ability of supplying itself for some years with cheap raw material, may have influenced the establishment of two other cotton textile mills: El Provenir, a few kilometers from Monterrey, in 1872, and La Leona in 1874. These three factories, now equipped with modern machinery which has greatly increased their capacity, continue to operate successfully, although El Provenir is the only one still operated by water power.

With respect to the last-named mill, as illustrative of the progressive spirit of the people of Monterrey, it should be noted that it installed electric light for its own use and that of the small workers' village in its vicinity before electric light service was installed in Monterrey, and this,

when in Monterrey public electric light service was inaugurated on the 24th of June, 1891, just nine years after the first public electric light service in the world was installed.[3]

On the 15th of August, 1870, telegraph service was inaugurated between Monterrey and Mexico, and in 1881 it was extended to Laredo.

Independently of the cotton factories, which have been mentioned and which may be considered as large factories, there were by 1880 a considerable number of small factories. This is confirmed by the fact that in the same year an exposition of local products was held at which there were 115 exhibitors who showed 461 objects, including starch, cornstarch, cotton and silk cloth, matches, candles, soap, hats, bronze, sugar mills, etc. The interest in and tendency toward industrial production continued to develop. Eight years later another exposition was held. Many of the articles exhibited at this exposition were also exhibited at the International Exposition held the same year at San Antonio, Texas, where prizes were awarded to them. The next year they were sent to an exposition in Paris.

At the end of the year mentioned, that is on the 21st day of December, 1888, the State of Nuevo León enacted the first law which granted protection to industry by exempting it from taxes for a given period or reducing the taxes imposed on industry. It thus created a precedent which is maintained to this day and which has been an important factor in the industrial development of the City of Monterrey, not only on account of the economic advantages it implies, but also because it demonstrates the friendly attitude of the state and its government towards this kind of enterprise.

In the year 1882, the railroad track connecting Monterrey with Laredo reached Monterrey. Shortly thereafter rail connection was established with the City of Mexico, In 1891, the first trains ran between Monterrey and Tampico, and shortly thereafter railroad lines were constructed between Monterrey and Torreón and Monterrey and Piedras Negras. In 1905, the rail line to Matamoras was inaugurated, thus integrating the system which made Monterrey an important railroad center in the country.

Speaking of the construction of railroad lines which were such an important factor in the development of Monterrey, I wish to make special reference to a North American citizen who is remembered with much affection in the city. I refer to Joseph Andrew Robertson, or Colonel Robertson, the name by which he was best known. Born in 1849 at Bakers, Robertson County, Tennessee—a county named for his ancestors, one of whom was the founder of Nashville, Tennessee—Colonel Robertson was an attorney-at-law who also held the rank of Colonel. He came to Monterrey at the time the railroad lines were being developed. He took an active part in the construction of the Piedras Negras line and later

[3]September 4, 1882, with 54 customers. Edison perfected his inventions for electric light on October 21, 1879.

organized the company which financed the Monterrey and Mexican Gulf Railroad, the line to Tampico which he constructed and managed successfully. In love with Monterrey, he made it his home. A man of extraordinary vigor and forcefulness, he devoted his energies to the development of this section of the country. He it was who brought budded oranges and fruit trees from California and initiated the orange industry, source of great wealth in an extensive region near Monterrey. He was also the initiator of some of the great industries that now exist in the city. He founded and published for many years a daily newspaper, *The Monterrey News*. He established street car lines, was the concessionaire for the water and sewer systems, co-operated in the planification of the city, and in general devoted his efforts, his capacity, and his enthusiasm to the service of the city of his adoption. His son, Ayres, beloved of everyone, still lives in Monterrey with his wife. His daughter, Georgia, granddaughter of the Colonel, is married to a member of a distinguished Monterrey family and is the mother of several Mexican children. Colonel Robertson is remembered in Monterrey, as I have said, with deep affection and gratitude. He was a great ambassador of the United States and one of those who has contributed most to better knowledge and better understanding between the two neighboring countries.

In the meantime industrial activity continued to expand slowly but steadily. By 1885, in addition to the three textile mills described, there was also a starch factory, a flour mill known as Jesús María, which is still operating, and a brewery and ice factory. During this same year, telephone service was inaugurated in Monterrey with forty telephones.

In the year 1889, an iron foundry was established, but it operated only a few years. In 1890, several Monterrey residents organized a company known as Cia. Fundidora y Afinadora de Monterrey, S. A. (Monterrey Smelting and Refining Company, Inc.) which operated successfully and was later acquired by North American interests, who still run it under the name of Cia. Minera de Peñoles, S. A., a subsidiary of the American Metals Company. The next year, 1891, the Guggenheim interests started construction of a large smelting plant, which is now owned and operated by the American Smelting and Refining Company. Similarly, on the 5th of May, 1900, Mexico City and Monterrey men organized the Cia. Fundidora de Fierro y Acero de Monterrey, S. A. (Monterrey Iron Foundry and Steel Company, Inc.) and established its plants at Monterrey. It is the largest of the three and is still successfully operated by Mexican capital under Mexican management.

It may be said that Monterrey's real industrial development has taken place during the past sixty years. It was slow in getting started during the first thirty years, but it was accelerated during the last thirty. It has always had to overcome difficulties of more or less importance.

What have been the causes which have determined that Monterrey should be an industrial city? Logically it would appear that it should not

be since it is not near an abundant source of raw materials or fuel and is distant from the great consuming centers.

Without attempting to give a complete explanation, I should like to point out some of the causes, which in my opinion, have had and continue to have an important influence. In the first place, the original founders had to be strong and aggressive to reach these desert regions of New Spain. Then, in view of the constant struggle which they had to maintain against a hostile environment, lacking rich lands for agriculture or cattle raising and without an abundance of minerals, only a great love for the place and a tenacity of purpose to win prevented them from abandoning the town and seeking more fertile fields. To struggle was considered a natural concomitant of life. The character of these people was tempered, and a tradition was formed which has endured even unto our day, a tradition of tenacious work which measures the results in proportion to the difficulties which had to be overcome.

The sterility of the soil was also an influence, not only in the moulding of the character of these people but, since it denied them means of work and a living, it compelled them to direct their efforts towards the transformation of what is produced easily in other sections, to make it more valuable and useful. This implies more specialized and constant labor, perseverance, technical organization, and a willingness to take risks and assume responsibilities, qualities which have been developed in the native sons of this region. The initiation of industrial life in Monterrey coincides with the first epoch, more or less lengthy, of peace and tranquility which the country experienced in its independent life from 1880 to 1910.

Great importance should also be attached to the moulding of the destiny of the city by two governors—Lázaro Garza Ayala, the lawyer, and General Bernardo Reyes, who were the incumbents during the period of peace to which I have referred. General Reyes was Governor of the State of Nuevo León from 1885 to 1887 and from 1889 to 1909, and Lic. Garza Ayala for the two years from 1887 to 1889. It was Governor Garza Ayala who organized the exposition of 1888 and who issued during that same year the first law granting exemption from taxation to industries. General Reyes, during his twenty uninterrupted years as governor, not only maintained the franchises granted to industry but added to them. He encouraged Monterrey's industrialists and invited others from different parts of the country. He also invited foreign capital to come and invest. He encouraged the building of railroads, planned a greater city, and secured electric light and power, water and sewer systems, these last being models in their class. The water and sewer systems were constructed and financed by a Canadian corporation, which owned and operated them until quite recently when they were acquired by the government of the state. With due regard for industrial development, he was also very much interested in seeing that the rights of labor be respected. It was through his influence that an eight-hour day was

established voluntarily by many local industries at the beginning of the present century, and in 1906 a law was enacted covering indemnification for occupational accidents. The exposition of motives for this law admitted the theory of professional risks. An interesting point in this law of indemnification for accidental death is that the sum fixed is exactly the same as that fixed in the Federal Labor Code, which was enacted over twenty years later. Another factor of importance was the construction of railroads which made Monterrey a railroad center with lines converging from six directions, making it easy to bring in raw materials and ship out manufactured products.

Lastly, I should mention a phenomenon of much importance in the destiny of Monterrey, which has had great influence in the development and prosperity of the city and the conservation and fixation of the characteristic qualities of its inhabitants. During the last years of the nineteenth century, at the end of a period of almost continuous revolution, dating from the time of independence, an intense desire for peace and tranquility to work was felt throughout the whole country. Monterrey, due to the various causes which I have pointed out, was probably ahead of other sections in creating a favorable atmosphere for the development of latent energies in search of a proper course to follow. It soon became general knowledge throughout the entire Republic that one could work in Monterrey; that large enterprises were being developed under the stimulating program of a government which welcomed all useful activity; that work was to be had; and that opportunity and guarantees could be counted upon. From that time on an emigration from all parts of the Republic started toward Monterrey, but particularly from the northern states of the country, whose inhabitants possess similar characteristics to those of the Nuevoleonites. This emigration consisted of laborers, artisans, people with small capital, all of whom were ambitious, resolute, and confident of their ability to succeed. An immigrant is always, or at least in the majority of cases, a strong, dissatisfied man, who has faith in himself, is not afraid of the future, and is ready to work and struggle. Thus Monterrey received an influx of beneficial and useful immigration of capable people which was quickly assimilated into the life of the city. This was not difficult since they were the same kind of honest, tenacious people; and they, by choice, became Monterreyites. Being a Monterreyite ceased to be a geographical accident and became a common interest and thought, an attitude, a way of life. And Monterrey did not disappoint them. They found what they had been looking for. The city was kind to them, and they were grateful. Monterrey owes much of its prosperity to those, who having been born in other places, chose Monterrey as the scene of their efforts, the place where they could succeed by the sweat of their brows or by the force of their intellect, wherein they could establish their homes, and where they would leave, when answering the last call, a factory, a shop, a center of creative activity as a token of gratitude and descendants able, willing, and determined to carry on a tradition of

honest labor and effort, which in the course of time is building a city and making a country prosperous.

And so it was that this industrial city continued to grow. Conditions were favorable. Industrial life was developing steadily. There were very few troubles with large capital that came with the idea of exacting a lion's share. Large exploiting companies, whose policy of regarding labor as a commodity to be acquired at the lowest possible price, a policy of sowing the wind and reaping the whirlwind, have not come to Monterrey to locate. In their place many small concerns were established. The owner and the worker went hand in hand in the common adventure. The investor was also the manager. He knew his men and was their friend. Labor was not a commodity but the effort of a human being co-operating in a common cause. The poor man and the rich man, the owner and the laborer, both worked and both still work. Important positions have been and still are open to anyone who by his honesty, capacity, and industry can qualify to hold them. Many of the present owners of large concerns were laborers thirty or forty years ago. Many of the managers who administer large businesses today (the Steel Plant, the Brewery, the Glass Works and the Cement Factory) entered the service of their respective concerns as unimportant workers or clerks holding lowly jobs. And, so, these small concerns overcame their difficulties and have made steady and regular growth. It was necessary to experiment and learn, to solve technical problems of organization, production, and marketing, to improvise, to invent, to make mistakes and to correct them, until the final success was achieved.

Industries, such as the Vidriera Monterrey (Monterrey Glass Works), failed three times and three times had to be re-organized and its entire capital had to be put up again. Expert glass blowers were brought into the country from abroad and failed. Different machines, procedures, and methods were tried out until success was finally attained. Today, the Vidriera Monterrey, with its subsidiary industries, is the largest producer of glass products in Latin America. Now its own engineers design and its own shops construct part of the delicate machinery which it requires, and its products are sold all over Mexico and in some Central and South American countries.

The prosperity and growth of some industries created a demand for other industries to supply them with raw materials or other necessary articles for production, packing, transportation, advertisement, and sale of its products. At the beginning, when production was limited and it was not possible to secure such articles in the country, they had to be imported at high prices. Later, when production increased to a profitable basis, the company had to manufacture such articles in its own shops, but when this production reached higher levels, requiring more attention and capital, the organization of independent companies was encouraged to produce these necessary raw materials, or accessories, and with an

immediate market for their products assured, they increased their own production to supply markets in the rest of the country.

A case in point, which may be cited, is the Cervecería Cuauhtemoc, S. A. (the Cuauhtemoc Brewery) producer of Carta Blanca beer. Founded in 1890, it soon began to need great quantities—at that time—of bottles. These were not produced in the country. Before nine years had elapsed some of the principal stockholders of the brewery invited other Monterrey businessmen to join in the establishment of the factory to manufacture bottles and other glass products. The new enterprise was organized on the 20th of April, 1899, and was the forerunner of the present Vidriera Monterrey. The brewery needed crown corks, when these came into general use, and packing boxes. They shortly began to produce them in their own shops in quantities sufficient for their needs, but to keep in line with modern progress they substituted corrugated board cases for the old wooden boxes. However, the demand for this product became so great, not only for the needs of the brewery but also for consumers in the rest of the country, that they initiated and co-operated to a large extent in the organization of two independent companies for the manufacture of the articles in question. In this way Fábricas Monterrey and Empaques de Cartón Titán came into being.

The glass industry, which came into existence mainly to supply bottles for the brewery, now manufactures all kinds of glass containers, such as milk bottles, wine bottles, bottles for mineral waters, for medicines, for toilet articles, for lotions, for creams, etc., glass for windows and covers, glassware and glass utensils of all kinds and for all uses, and all these products are extensively consumed, as has been explained, throughout the country and also are exported to Central and South America. The glass factory also has co-operated in the orgnization of companies to manufacture moulds, machinery, the productions of soda ash, etc. Fábricas Monterrey started its operation by producing crown corks for the brewery and now produces crown corks, metal cases, screw tops of all sizes, sanitary covers for milk bottles, lithographic advertisements on metal sheets, trays, cork plates, and bars for the whole Republic, and is now experimenting with plastic material and starting production on a small scale.

During the late war, there was a time when Fábricas Monterrey encountered almost insurmountable difficulties in securing the tin plate which it needed for the production of the articles it manufactured, particularly crown corks. Aided by the brewery, it was an important factor in the establishment of the factory known as Hojalata y Lámina, for the primary purpose of producing the steel sheets necessary for the manufacture of crown corks. This concern now sells its products, far in excess of the needs of Fábricas Monterrey, all over the country. With reference to Empaques de Cartón Titán, it may be said that this concern is now producing all kinds of packing cases for every class of article for the needs of all kinds of manufacturers throughout the country. It also

produces a part of the craft paper it needs, as well as gummed paper, and it is experimenting in the cultivation of bambu (phylostachies bambusaides) to be used as a raw material. Before the late war this concern exported its products; but during the war it had to suspend exports for lack of sufficient raw material, although it has now resumed exports to Central and South America.

One of the difficulties which has stood in the way of industrial development in Monterrey has been the lack of an ample market for securities, which could easily absorb issues of stocks and bonds. Banking facilities are also insufficient for the requirements of industry. This has limited growth and development, but on the other hand, due to this cause, development may have been slower but it has been more conservative and more stable. The industrials have found it necessary to reinvest the greater part of their profits. Their capital has gradually increased but it is always invested and devoted to the social function of economic production.

In 1930 and 1931 banking activity in Monterrey suffered a depression, as a consequence of the grave economic crisis which started in the United States in 1929 and reached Mexico a short time thereafter. At this time the principal industries in the city got together for the purpose of organizing a bank that would serve as a stimulant for the other banking institutions and through which they could have a voice in the banking system and inspire confidence in the future of the country. In February, 1932, during one of the most difficult epochs in recent years, Crédito Industrial de Monterrey opened its doors with a capital of $250,000.00, to join in the efforts of the other banks of the city.

At the present time its capital and reserves exceed $5,000,000.00 pesos. It operates with a head office and three branches in Monterrey, branches at Matamoros and Reynosa in Tamaulipas, Torreón in Coahuila, and one in the City of Mexico. The large industries in Monterrey continue to be its principal stockholders. It now has more than three thousand depositors with assets approximating $60,000,000.00 pesos.

Long-term financing is one of the constant needs of industry. With the idea of meeting this necessity, at least in part for the future, and because of an interest in the progress of the city, the businessmen of Monterrey have organized eight finance corporations. In order to integrate the system more completely, three institutions were organized in 1940—a life insurance company under the name of Monterrey, Cia. de Seguros sobre la Vida, a savings bank under the name of Banco Capitalizador de Monterrey, and a mortgage loan bank under the name of Crédito Provincial Hipotecario. These institutions operate all over the country through branches and agencies, but their main offices and the majority of their stockholders and directors are Monterrey men.

The insurance company had on the 31st of December, 1948, that is, when it had attained eight and one-half years of operation, insurance in force to the amount of $326,500,000.00, reserves exceeding

$18,000,000.00, and during the last year collected more than $10,400,000.00 in premiums. The Banco Capitalizador handles savings deposits of more than forty thousand customers, and last year it collected savings on a long-term plan in excess of $14,000,000.00 pesos. Its invesments now exceed $36,000,000.00 pesos. Crédito Provincial Hipotecario now has outstanding time loans for from three to ten years to the amount of $24,000,000.00.

The industrial history of Monterrey leaves the impression of being the description of a steeple chase with many and difficult hurdles. In 1940, it was found that the generating capacity of the power plants of the public utilities supplying electric service to the city was not enough to take care of the constantly increasing demand created by the growth of the city and its factories. The Canadian company, owner of the plants, had always given dependable and efficient service, but at that time, for certain reasons, did not believe it advisable to make the substantial investment required to increase its capacity. The big smelters and some of the factories located on the outskirts of the city had their own power plants, but all the rest were dependent on the public services. Inasmuch as it was evident that a large plant would be more efficient than several small ones, fourteen companies, headed by the Cuauhtemoc Brewery, the Glass Factory, and the Cement Company, grouped together, and through their joint efforts built for their own private use a thermal electric plant of 17,500 KW capacity and its complete distribution system, using new equipment throughout. This capacity is at present insufficient, and steps are being taken to increase it. The power that these industries took from the public utilities company was left for the use of the smaller industrial customers that could not afford to invest in their own power plants. In a very short time this energy was absorbed by the growth of the smaller factories; and general conditions having improved, the power company increased its capacity to 25,800 KW, and I understand that it has under study the possibility of increasing it further to about 60,000 KW within the next five years, considering that the demand would require such additional capacity.

A few years later, in 1943, what had happened about power in 1940 was taking place in regard to fuel. Since 1930, Monterrey had been supplied with natural gas for domestic and industrial uses by a company, which until the latter part of 1945, was a subsidiary of United Gas. The service was excellent, but by 1943 it became evident that the company's pipe line, extending from Roma, Texas, to Monterrey and with a capacity of 30,000,000 cu. ft. a day, would very shortly be inadequate to supply the demand. The United Gas Company decided it could not build the new pipe line required. The problem was very serious. To try to substitute gas for oil was practically impossible. If no additional supplies of gas could be obtained, growth in the producing capacity of the factories served was impossible. In a short time, a reduction in operations would have become necessary, resulting in unemployment and grave damage

to the whole economy of the country. Many of the products manufactured in Monterrey were essential to other industries and could not be imported on account of the war. The directors of the companies that had built their own power plant met again. To the meetings this time came the representatives of the Steel Mill, the largest single consumer of the city, and the representatives of other companies. The decision was unanimous. It was essential to find a new firm and a reliable supply of gas and, if necessary, to build a pipe line. Every effort should be made to avoid the disaster that the lack of fuel would have meant.

In July, 1947, gas began to flow through the new 14-inch, 129-mile pipe line, with a capacity of 60,000,000 cu. ft. a day, owned by the main industries of Monterrey and destined exclusively to supply their needs of fuel. The corporation organized to build and operate the pipe line is Gas Industrial de Monterrey.

All kind of difficulties had been overcome to solve the two serious problems, lack of electric power and lack of fuel—two essential elements to industrial life and the development of the City of Monterrey. In both cases we had the decided help and the full, consistent, and valuable co-operation of the Mexican Government and the Government of the United States. Without the sympathetic help of one or the other of the two governments, we would have failed, and the activity of Monterrey would have been reduced to less than 50 per cent of what it is today. We have to remember that both projects had to be planned, studied, and executed during the war or immediately after the end of the war. In the case of the power plant, we knew where to go to get machinery, turbines, boilers, and technical help; the main problem was in being able to obtain for industrial uses, outside of the United States, material and equipment that was essential to the war effort. In the matter of the gas supply, besides those problems (and all of you know what it meant to be able to have manufactured for you and be allowed to export 129 miles of 14-inch steel pipe of the best quality, which required for transportation over 300 railroad cars), we had to start by finding a reliable gas supplier, willing to enter into a contract with us and having at his disposal gas fields with proven reserves, ample enough for our estimated requirements for at least ten years, because industry has to be assured of a dependable supply of fuel without interruptions for a reasonable time. Furthermore, the large investment that the transportation of gas requires, both for the seller and for the buyer, makes long-term contracts essential. Fortunately, after several tries, we were able to meet an outstanding group of Corpus Christi businessmen, the La Gloria Corporation and its subsidiary, the Reynosa Pipe Line Company, who could give us very amply the assurances we required and with whom Gas Industrial signed a contract. The industrials of Monterrey who manage that Company are proud to have had the opportunity of having met and done business with men who are a prestige to the businessmen of their state and their country, like Robert T. Wilson, whose early death we all mourn, John Lynch, Binford Arney,

and their associates. Having found the gas, the export permits had to be obtained; the production of the pipe came next; the allocation of steel, etc.; then the export permits for the pipe, transportation facilities, etc. All this was possible, as I have explained, thanks to the unfailing help of the Mexican government and the determined co-operation of the government of the United States that in the two instances proved definitely that the Good Neighbor Policy is not just a kind phrase in a diplomatic note, but a real purpose translated into real and tangible acts of the highest value. Monterrey was able to avoid once more the disaster that threatened a large part of its activities with paralysis. We confidently hope that in the future, when we have faithfully complied with our obligations in the contracts with our esteemed suppliers, we may be able to carry on the development of our city and its industries by using our own Mexican gas in our factories.

Serious thought is given by the businessmen in charge of management of big industries to the establishment of cordial relations with their workers. Nothing sound and lasting can be built upon injustice. Social peace, essential to an efficient production, can only be obtained through the recognition of the human dignity of the worker, with the recognition of his needs, his rights, and his ambitions.

Special departments, headed by specialists in every industry of any importance, study the specific problems of labor relations and make suggestions and recommendations. The workmen, in addition to their salaries, are entitled free of any charge—all costs are paid by the companies—to complete medical care, including medicines, for themselves and for all their dependents, covering not only professional sickness and accidents but accidents and sickness of any kind. In many instances this medical care includes special treatments, operations, hospitalization, complete dental service, maternity cases, etc. Employees get full salary during their sick absences. They have life insurance and pensions for disability and old age, and they enjoy yearly vacations with full pay. In all factories the workmen are encouraged to take part in any sport they may choose, the companies providing the uniforms, gloves, balls, and all equipment. The men are induced to save part of their salary, the employer paying a substantial interest on the savings or contributing to the savings account amounts in proportion to those set aside by the workers. The companies give advice to their men on all kind of matters, including legal advice. Some corporations employ women social workers, who visit the families in their homes to advise and help them on matters of health, clean living, balanced diets, care of children, etc. Some factories have built and operate kindergartens and grammar and high schools, where their workers' children get a free education, including books, etc. As an example, I can mention the Adolfo Prieto School, organized in 1911 by the Compañía Fundidora de Fierro y Acero de Monterrey (Monterrey Steel Mill), which today has magnificent buildings and playgrounds and an enrollment of more than 1,600 boys and girls.

Besides elementary education, many corporations grant scholarships to attend universities and technical colleges, at home and abroad, for workers' children who have the necessary intelligence and willingness to benefit by them. The men are helped to buy or build their own homes, sometimes through the purchase of big tracts of land and large amounts of building materials, which are sold to the men at cost on the installment plan, without interest, and sometimes by the companies taking care and absorbing the financing cost of long-term building loans. In the older factories it is not uncommon to find that the vast majority of men with dependents own their own homes.

Many companies advise and help their workers to increase the purchasing power of their salaries and to make the best use of it by means of wholesale purchases of essential commodities made through co-operative organizations of the workers, or by subsidizing these purchases, so that the worker may buy at a price substantially lower than the prevailing market prices, the amount of goods that each workman has a right to obtain at these reduced prices being in proportion to the number of his dependents.

Some companies get together in order to be able to grant even greater benefits to their workers through the opportunities afforded by greater numbers. These benefits are granted sometimes by the companies themselves, sometimes through recreational societies, organized and managed by the workers themselves. As an example I would mention the Cuauhtemoc Famosa, a workers' organization that takes its name from the larger two of the eight industries whose employees belong to it: Cuauhtemoc Brewery and Fabrics Monterrey. This society has over four thousand members. The companies extend to their workers all of the benefits which I have mentioned before, but some of those benefits and some additional ones are granted through the workers' society. In Cuauhtemoc y Famosa the worker members have accumulated a savings fund amounting to $3,898,947 pesos as of the 31st of December, 1948. The organization has the use of a big social, sports, and recreational center built, equipped, and maintained by the companies. It occupies twenty-four acres of valuable land close to the city. The center has a large and beautiful building with halls and terraces for social events, billiard rooms with fifteen tables, indoor sports, a library, classrooms where classes are held for the benefit of the workers and their families on English, dressmaking, cooking, home economics, music, ballet, drama, etc. It has a soda fountain and a restaurant, where a full, healthy, and properly balanced meal can be obtained for a fraction of its real cost. On the grounds, there are several tennis courts, a gymnasium, showers, dressing rooms and lockers, three swimming pools—one of olympic size for men, one for women, and a large wading pool for the children, who have their own special section with a private playground arranged with merry-go-rounds and all kind of games, their own small showers, dressers, and lockers. In the park, there is an open-air theater with a seating capacity of several thousand specta-

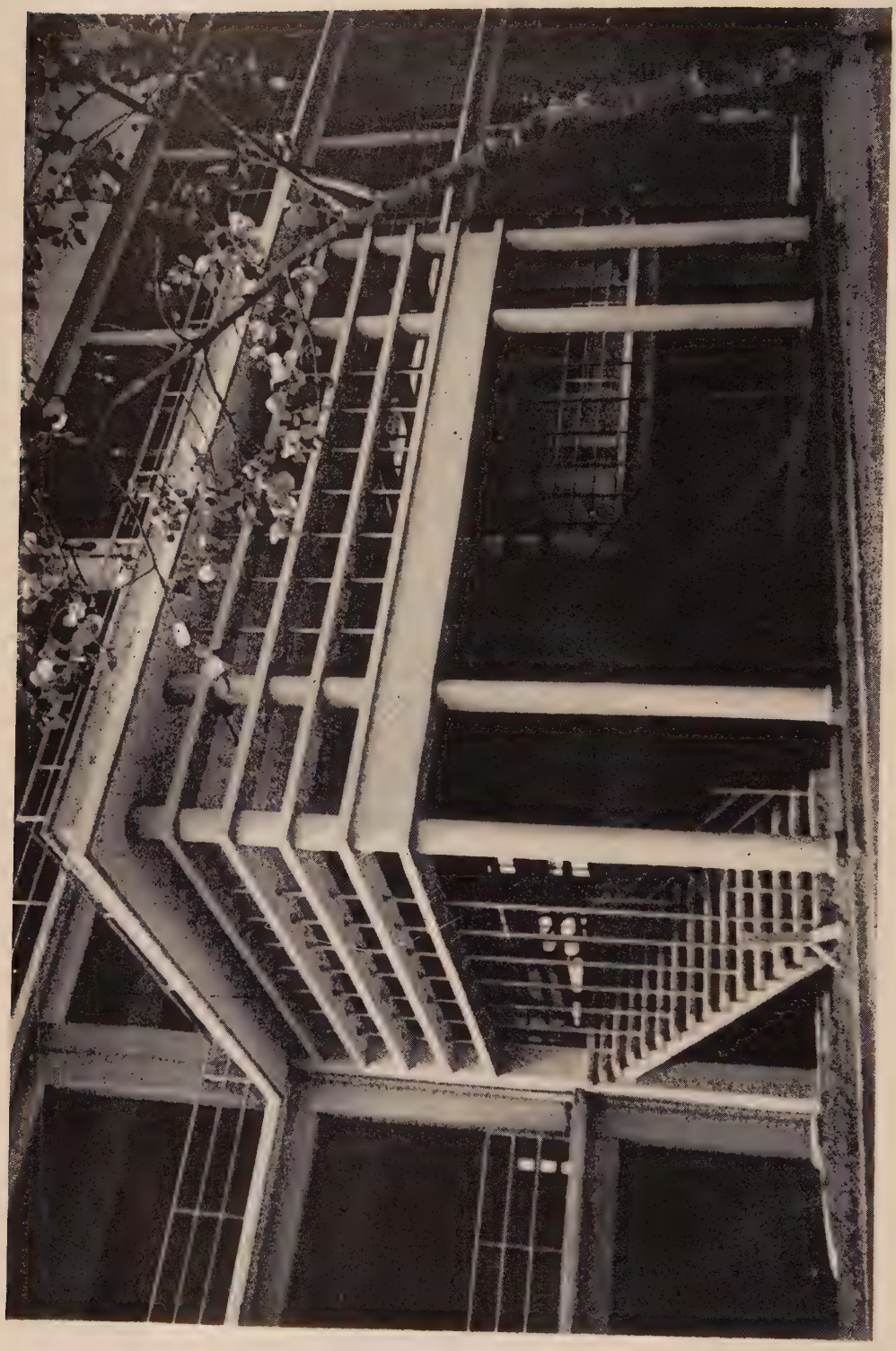
tors, where the Drama and Art Club, formed exclusively by workers and their families, periodically stages theater and ballet shows and gives concerts, affording its members the opportunity to develop their artistic abilities. There are also parks and courts for playing all known sports, including a baseball and football park large enough to permit the playing of several games simultaneously and a steel and concrete grandstand with three thousand seats. There are professional instructors for all sports, and many leagues, comprising several teams each, are organized. Events for children and grownups are taking place constantly.

The Cuauhtemoc y Famosa Society provides complete medical service to 15,000 persons, workers and their families, with an average of 900 daily consultations in the clinic and 50 daily visits to homes by the clinic doctors, who also take care of 50 maternity cases a month. Through the society, 3,000 workers' families, totaling 15,000 people, can obtain foodstuff and clothing at less than cost prices.

I should also mention the Acero y Vidriera suburban development, where large numbers of the workers of the steel mill and glass factories have their homes. These homes are of permanent and solid construction, clean, healthy, with electricity, water, sewer, and natural gas services, on paved streets and each with its own small garden. The Acero Sports Park, The Fourth Annual Athletic Meet Acero, which has just taken place at the Acero Sports Park, was organized, like many other events, by the steel mill recreational department and was attended by many competitors from Monterrey and other northern towns. Worth mentioning also is the María Josefa Maternity Hospital, built and subsidized by the steel mill since the 10th of May, 1945, with conveniences similar to those found in the best institutions of its kind, where the workers' wives receive the best and most complete attention.

Relations between management and labor are carried on in Monterrey in an atmosphere of understanding and in a spirit of co-operation. It is important to note that the large majority of the city workers has been reluctant to affiliate their unions to the country-wide organizations, and they have formed their own Association of Independent Unions of the State of Nuevo León. Almost all of them are opposed to communistic doctrines, and they have demonstrated this since 1936, when they took part in a big demonstration held in that year in Monterrey, with an active attendance of over 60,000 people, to protest publicly against communist agitation which was spreading at that time throughout the country.

Industrial Monterrey is not only a group of large industries, employing several thousand workers, but also a large number of small factories, where the owner and his men work side by side and where sometimes the workers are partners in the enterprise. It is the same process, repeated in hundreds of cases, followed 20 or 30 or 50 years ago, by those who today constitute the large industries of the city. Humble beginnings but ambitious dreams have become successful achievements through unfailing faith, tenacity, and constant effort.



Technological Institute of Monterrey

Not including the big factories that, as we have seen, have their own power, the Monterrey Light and Power Company supplies electric power to more than 1,600 independent factories and shops of all sizes. More than 400 different products are manufactured in Monterrey: steel in all forms (installed capacity: 300,000 tons a year), beer (1,500,000 bottles a day), all kind of glass products, cement and brick, machinery, electric lamps, wood and steel furniture, flour, textiles, paints, batteries and dry cells, plastic articles and the raw materials to produce them, silver tableware, etc. Industrial Monterrey uses more than 222 million KWH a year and around 50 million cubic feet of gas a day.

A big handicap in the development of industry in Monterrey, and all through my country, is the lack of men with the technical knowledge needed for production. With the purpose of trying to solve, even in a small way, this problem, several industrialists of Monterrey founded, at the close of 1942, the Technological Institute of Monterrey, using as a model—ambition never lacking—the Massachusetts Institute of Technology, where some of its organizers had obtained their degrees. Very soon encouragement and valuable help were received from all of Monterrey's businessmen and from many others in all parts of the country. Now, less than seven years after its organization, this technical college owns four imposing four-story buildings with well-equipped physics, chemical, and electrical labatories, class and lecture rooms, dormitories, shops, and excellent library, a cafeteria and dining room, playgrounds, and a swimming pool, all on a 40-acre tract of land, a few minutes distance from downtown Monterrey on the road to Mexico City. Its assets are worth over twelve million pesos. It has a student body of 1,300, of which more than 50 per cent are from out of town, from all the states of Mexico, and from some Central and South American countries as well.

The faculty is made up of ninety resident professors, selected from Mexico and from abroad, who devote all their time to teaching and research at the institute, helped by twenty-five assistant professors, chosen from the best professional men in the city. There is a preparatory school, a college of engineering with schools of civil, mechanical, electrical, and chemical engineering, the faculty of economics, business administration and accounting granting the degrees of private accountant, banking, certified public accountant, and business manager. There are also technical schools for workers, with night classes and brief and specialized courses on mechanics, electricity, chemistry, designing, and drafting. The institute has, besides, an agricultural school and a school of architecture and is planning the organization of schools of biological chemistry and industrial chemistry.

The requirements of study and personal work are strict, and the discipline is remarkable, inasmuch as the institute only accepts capable students who are resolved to benefit by the opportunity afforded them. About 30 per cent of the students enjoy scholarships offered by the corporation to boys in reduced circumstances, who have proven themselves capable

Technological Institute of Monterrey

and are desirous of learning The Tecnológico has encouraged the playing of American football, and a few months ago announced its intention of building a stadium. To finance construction of the first section to be built with 10,000 seating capacity, it offered for sale 1,000 seats for the life of the stadium at 1,000 pesos each. In less than fifteen days, the 1,000 places were sold in Monterrey, and many excess applications could not be filled, having been reserved for the time when the second section may be built in the future.

This establishment of learning, which undoubtedly will have a great influence on the future development of Mexico, was made possible by the efforts of a handful of Monterrey business and professional men, who generously devote to the institute part of their time and energy, and through the business concerns of Monterrey and the rest of the country, who have provided the necessary funds for its foundation and who contribute liberally to cover its budget.

The data that I have given you, the figures that are cited in my study, are humble, small figures compared to those with which you are familiar and that might refer to any of your cities in your country, the largest industrial country in the world. But we must remember that industrial life in Mexico is just a few years old, that we have been faced with difficult problems that you never had to deal with, and that we are beginning to realize, fortunately, that the legend that Mexico was a rich, a very rich country, was just the unfounded impression that our beautiful scenery, our mountains, and our vast stretches of land left before the admiring eyes of the first Spanish colonists and some European travelers that visited Nueva España before our independence. When we consider that only a very small fraction of our territory is susceptible to irrigation and that our natural sources, large as they may have been, might be exhausted, we have to turn our eyes to industry, which is as permanent as are the effort and the work of man. Monterrey, then, being the outcome of that effort, the result of the tenacity to overcome difficulties, does not appear to us as a definite accomplishment, but as a possibility, as a sign that shows a way, as an act of hope and faith in the future of Mexico.

THE OIL INDUSTRY IN THE NORTHEAST OF MEXICO

ANTONIO J. BERMÚDEZ*

Director General, Petróleos Mexicanos, Mexico

It was a very pleasant surprise and indeed a great honor to be invited by Mr. Eastin Nelson, Chairman of the Conference Committee of the Institute of Latin-American Studies of The University of Texas, to address this select audience on a subject so particularly important to me as is the development and prospects of the Mexican oil industry in the northern part of my country.

With no hesitation whatsoever, I accepted the kind invitation bearing in mind that neighbours can only exist happily if they are the best of friends, and truly that friendship can be cemented only if there exists a mutual knowledge and understanding of problems, of hopes and efforts, of successes and failures, that may give rise, when necessary, to sympathetic judgment and even helpful aid.

From El Paso to the mouth of the Rio Grande, 1250 miles of common borderline have created a natural bond between your great state and my country. If this bond is to be a friendly one—and let us hope that it will always be so—it is high time that frank discussions of the great number of problems that have bearing on the economic lives of our respective peoples are periodically undertaken. The University of Texas deserves the highest commendation for this magnificent effort in the fostering of American-Mexican relations, and I am sure that this regional industrial conference will serve the purpose of awakening the dormant interest of the peoples of Texas and Mexico in the cultural and economic evolution of each other and will result in a higher degree of understanding and a better-founded mutual respect.

It is of particular significance that I should speak on the oil industry of Mexico in the heart of a state that is rightly considered as the nerve centre of the world's oil industry. Texas produces about 44 per cent of the oil of the United States of America and 27 per cent of the oil of the whole world. It produces more oil than any single country in the world and sinks more wells every year than any other state of the United States and any country outside yours. Texas is one of the parts of the world where the "know-how" of the oil industry is better developed, and it is in this great state where new systems for improving present methods are constantly under study and where new techniques have a wonderful field for experimentation.

Mexico once occupied a very important position among the oil-producing countries. In fact, for several years it was the second oil-producing country in the world, reaching a peak of 193 million barrels in 1921. In

*Senator Bermúdez was unable to attend the conference, and in his absence his paper was read by Ingeniero Manuel Rodríguez Aguilar, head of the Explorations Department of *Petróleos Mexicanos*.

that year Texas produced 106 million barrels. After that time the oil production of Mexico suffered a constant decline, until its lowest ebb was reached in 1932 when we produced only 33 million barrels, while that same year the production of Texas was 312 million barrels. Between 1932 and 1942 the production of Mexico had many fluctuations, but from 1942 on, a definite increase has been effected, and during 1948 a total of 59 million barrels was obtained, which compares with around one billion barrels produced by Texas during the same year.

Many were the reasons that brought about the great decline of the Mexican oil production, and it is not my intention here to analyse them. It suffices to say that this decline was not a consequence of the extinction of the oil possibilities of Mexico, since these possibilities only have been explored and exploited to a minimum degree and, in our opinion and in the opinion of many world authorities, they justify the hope of a future development of the Mexican oil industry parallel to that effected by Texas in the last twenty years.

The State of Texas, with a total area of 267,339 square miles, derives its present oil wealth from approximately 100,000 square miles of oil territory. Mexico with an area of 771,000 square miles has—according to our present geological knowledge—a total of 130,000 square miles of potential oil territory. This territory comprises the sedimentary basins that fringe the Gulf of Mexico from the Rio Grande to the Yucatán Peninsula and other large sedimentary basins that lie in the states of Chihuahua and Coahuila, in the Peninsula of Lower California, and in certain other regions of our Pacific Coast. The potential oil territory of Mexico, especially that situated along the coast of the Gulf of Mexico, is comparable geologically to that in Texas insofar as prospective wealth is concerned. On the other hand, while Texas has drilled, since the inception of its oil industry to the end of 1947 a total of 244,381 wells, the whole of Mexico has sunk only 6,825. You can realize readily, if you compare the above data, that the revival of the Mexican oil industry is a matter of vigorous exploration and development drilling.

The Government of Mexico, headed by President Miguel Alemán, has launched our country in a tremendous effort for an overall industrialization. We believe that an intensive but rational exploitation of our natural resources and a correlative expansion of our other basic industries is the only solution to our economic difficulties. We want to be prosperous for our own sake and for the sake of continental prosperity. A poor neighbor is not a desirable neighbor, and we intend to create wealth for our country through intensive production, and thus raise the standard of living of our people to a point comparable with yours, so as to participate fully in the benefits of modern life.

Industrialization is only possible if fuel and all the other derivatives of crude oil are at hand. It would not be healthy to depend on foreign supply of oil for the operation of our ever-growing industries, and since Mexico was endowed by nature with a great underground wealth, we

feel that it is the duty of the Mexican oil industry to assure the entire supply of our domestic market with all the petroleum products that are essential for our economic life. The industrialization growth of Mexico, the new roads that are being built by our federal and state governments, and the very encouragement that the availability of oil products at reasonable prices gives to the establishment of new industries, are factors that make us foresee a great yearly increase in the volume of our domestic needs.

On the other hand, the industrialization program of our government, which includes as a fundamental part of it the boosting of the oil industry, requires the import of a great diversity of equipment, for the attainment of which dollars are needed. An increase in our exports of oil products is therefore necessary to enable our oil industry to import the equipment required for its own development and to help establish a favorable overall trade balance.

It was therefore of paramount importance for our industrialization plan that Pemex, the Mexican government oil agency, became intensively engaged in the search for new oil reserves that would allow an adequate increase in our oil production in the shortest period of time. It was only natural that interest was immediately focused on the northern part of our coastal plain of the Gulf of Mexico, in the vicinity of which a great oil and gas wealth had been exploited in this state of Texas.

Our borderland of the states of Tamaulipas and Nuevo León is geologically a part of the great basin known to you as the Rio Grande Embayment. Its wealth in gas and oil per unit area should therefore be of a magnitude comparable to that of your oil province of southwest Texas.

In spite of these obviously favorable circumstances, the exploration of northeastern Mexico, undertaken by a number of private oil companies prior to the nationalization of the oil industry in 1938, was far from being a success. A total of 56 exploratory wells were drilled on the Mexican part of the Tertiary Rio Grande Embayment, but only three gas fields were discovered, namely the Rancherías, La Presa, and Chilpitín fields, all of them of small commercial importance. Several oil shows were found in some of the exploratory wells drilled, but none of the operating companies was able to obtain a single commercial oil producer.

In the year of 1942, Pemex began surface geological work and gravity meter reconnaissance exploration, which was followed in 1944 by an intensive seismic campaign along the border from the Reynosa area eastward and southward. Surface geological and gravity meter work was carried out by our own Mexican personnel while seismic exploration, which now involves the operation of four parties in this area, has been effected under contract with two reputable American exploration companies, namely: Geophysical Service Incorporated of Dallas, Texas, and Seismograph Service Corporation of Tulsa, Oklahoma. From 1942 to the present date the following areas have been covered by our work in northeastern Mexico:

	Square Miles
Surface Geology	2,500
Gravitymeter	14,150
Seismos	3,750

The number of men that are employed in this phase of exploration in this area is approximately 150.

The work I have just mentioned has resulted in the finding of a great number of structures, some of which have undoubtedly a first-class rating on account of both their aerial extension and their structural closure. There is no doubt in our minds that a great number of them contain a wealth of oil and gas, and this has begun to be substantiated by the results obtained by the drill.

Drilling in northeastern Mexico was started by Pemex in April, 1944, at what is now known as the Misión Field. Well Misión No. 1 was drilled in the vicinity of Arkansas Fuel Oil Company well Heard No. 1 in the Peñitas area east of the Sam Fordyce field and was based on detailed subsurface study of this field and adjoining areas. It resulted in the discovery of a gas and distillate field, and at the present time we have four producers in this field with a total daily production of 12 million cubic feet of gas and 110 barrels of distillate. No further drilling is being carried out in the Misión field.

After the discovery of the Misión field, the drilling activity in northeastern Mexico was considerably increased, and at the present time we have nine drilling rigs in operation which employ together with subsidiary activities a total of approximately 400 men.

I will give you now a short summary of the results obtained with the drill in other structures of northeastern Mexico which will enable you to visualize the great possibilities that exist in this part of our country. I want to refer you, however to a paper delivered by Mr. Eduardo J. Guzmán of our gelogical staff at the 15th Annual Meeting of the South Texas Geological Society held in Mexico City in October, 1948, which was published in the March 17th, 1949, issue of *The Oil and Gas Journal.* In that paper a comprehensive description of geological conditions found in the structures drilled by Pemex in northeastern Mexico can be found, and therefore I do not consider it necessary here to go into great detail in this particular aspect.

Reynosa structure.—This structure is located in the vicinity of the City of Reynosa, State of Tamaulipas, and this is the first structure where commercial oil was found in northeastern Mexico, thus substantiating the high hopes we always had in the possibilities of this area. It is an elongated, closed anticline, with a north-northwest south-southeast axis about five miles long and with a maximum width of about three miles. The first well was drilled between February and August, 1948, and discovered two oil and four gas sands in the Frío formation of the Oligocene. At the present time there are eight oil producers with a total production of 1700 barrels a day and a gas producer with a restriced production of one million

cubic feet of gas and 38 barrels of distillate per day. The possibilities of further development of this field are excellent, not only for lateral extention of the proven area, but for deeper production from the still unexplored Vicksburg formation. At the present time five wells are being drilled in Reynosa.

Carmargo structure.—This structure is located about two miles south of the Rio Grande, fifteen miles southeast of Rio Grande City, Texas, and about ten miles west of the Misión field. The discovery well was drilled in 1947, and at the present time we have two producers with a total capacity of 1.75 million cubic feet of gas per day with practically no distillate. No wells are being drilled now in this structure, but the complete development of the same calls for further drilling which will be undertaken in the future.

Valadeces structure.—A gas and distillate field, located about three miles east of Camargo. The discovery well and the only well thus far in this field was drilled in 1948 and produces 0.55 million cubic feet of gas and 27 barrels of distillate per day from sands of the upper Jackson formation. The complete development of this sand will require further drilling, but at the present time no wells are being drilled in Valadeces.

Brasil structure.—This is the largest closed anticline that we have found so far in northeastern Mexico. Its apex lies about 28 miles southeast of Reynosa and is 11 miles long and 6 miles wide, having a closure of at least 400 feet. The first well which was drilled in 1948 found several sands rich in gas and distillate within the Frio section of the Oligocene. Unfortunately a blowout resulted in loss of the hole, but a second well is now being completed with excellent prospects of becoming a large gas and distillate producer, and the structure still holds first-class prospects for the yet unexplored Vicksburg formation.

18 de Marzo structure.—This is also one of the largest closed anticlines of northeastern Mexico. It is located about 18 miles southeast of Brasil and 18 miles southwest of Brownsville, Texas. The structure is about 10 miles long and 7 miles wide with a seismological closure of approximately 500 feet. The first well was spudded in March, 1948, and, owing to mechanical difficulties, it has not been completed. Several promising gas sands and one possible oil sand were tested in the Frio section, and there is no doubt that here we have an excellent field. A second well is now being drilled in this structure.

Francisco Cano structure.—This structure is located 3.6 miles south of the Rio Grande and 16 miles east of Reynosa. The first well is now being drilled, and so far two excellent oil sands have been encountered and tested, so that it appears that we have a new oil field in this structure.

As a counterpart to the successes we have experienced in the exploration of the seven structures which I have just reviewed, we have so far met failure in the testing of three other structures also located in northeastern Mexico and on which we have up to the present time drilled one well

apiece. These structures are: China, in the State of Nuevo León, which we consider definitely condemned, and Las Norias, in the State of Nuevo León, and Treviño in the State of Tamaulipas, 6 miles east of Francisco Cano which still holds good prospects in spite of the failure of the first wells.

At any rate, should Las Norias and Treviño be unproductive, the percentage of successes that Pemex has had in the testing of the structures in northeastern Mexico would be 70 per cent, which we consider as an extraordinary result. We do not want to be overoptimistic and expect that in the future we will be able to hold the same record of success, but we want to emphasize the fact that up to now our results obtained in the Rio Grande Embayment give us additional hopes that this part of our country will eventually become one of the large productive areas of the world. Of particular significance also is the fact that out of seven fields that we have so far found in northeastern Mexico, at least two, and possibly three or more, are or will be oil producers.

The valuable information that we have obtained from the structures which we have drilled has allowed us to make a rough estimate on the amount of reserves that might be obtained from 35 structures of different rating that we have so far mapped in northeastern Mexico and which include the fields we already have discovered. The rough estimate of such reserves, is as follows:

Oil	720 million bbls.
Distillate	62 million bbls.
Gas from the oil fields	282,000 million cubic feet
Gas from gas fields	6,171,000 million cubic feet

The discovery of oil and gas in northeastern Mexico and the intensive developement of this wealth as a means of strengthening the economy of our country will require the construction of oil and gas lines to transport the production to refineries and markets in general. At the present time, our oil production from the Reynosa field is being shipped by rail to the United States and there bartered for gasoline that helps supply the domestic market of our border states. Our distillates from Valadeces and Misión are sold locally for tractor consumption, and our gas production from Misión, Carmargo, and Valadeces is sent to Monterrey through existing pipeline facilities, while the gas from Reynosa is being used as fuel in our own operations.

However, it will become necessary soon to increase considerably the means of making available the production of northeastern Mexico to a wider market. We intend to build, in the near future, a refinery in the City of Monterrey which will be supplied by a new pipe line. This refinery will take care of the needs for petroleum products in the north of Mexico and thus allow a larger export of our oil products from the Tampico area. We estimate that the size of the domestic market that will be supplied by the Monterrey refinery will between 25,000 and

30,000 barrels per day within the next five years. In addition, crude oil and products will be available, should necessity arise, for ready export to the United States of America through the border line.

The disposal of gas from the fields already discovered and from the ones yet to be discovered will have an immediate market in the area of Monterrey and Torreón and the nearby industrial centers of Saltillo and Monclova. At the present time Monterrey has its gas supplied mostly from Texas while neither Torreón, Saltillo, nor Monclova enjoy the use of that fuel. The present consumption of gas in Monterrey is 40 million cubic feet per day, but we estimate that the future consumption of the Monterrey, Torreón, Saltillo, and Monclova areas will be around 120 million cubic feet per day. We expect to be able to supply in the future all that gas market, and a gas line system from Reynosa, Brasil, and 18 de Marzo to those cities, is at the present time being planned. However, the amount of gas that we expect to have available from northeastern Mexico is so large that wider markets are required if we are to take full advantage of this great wealth. We intend eventually to build a line that will bring the gas from the Rio Grande Embayment into the valley of Mexico City through Tampico and the Poza Rica oil field. This project will enable us to speed up the repressuring of this field which is at the present time the most important in Mexico and will also be of great benefit to Tampico and other intermediate regions.

The availability of abundant gas in our Tampico refineries also will allow us to save liquid fuels in our operations and therefore be able to divert them to the domestic market or for export. In total, Tampico, Poza Rica, and the valley of Mexico City will absorb, according to our estimates, approximately 150 million cubic feet per day.

Lastly, but not least, is the potential market of our agricultural lands of our lower Rio Grande Valley. Soon there will be south of the border a total of around 750,000 acres of fertile land under irrigation, and the development of this great agricultural wealth and the establishment of derivated industries can only be properly enhanced if cheap and ready energy is available. Electric plants will be required in this area which will absorb a considerable amount of our gas production. This gas production and other petroleum products that our northeastern fields will yield will help to transform in a short time the northeast corner of Mexico into a great agricultural and industrial emporium.

I have briefly outlined what we have done and plan to do in northeastern Mexico and what are our hopes for this region of my country. That is for us only one of our petroliferous zones, and what we have done there is only an entry into the program we hope to accomplish. Over the entire nation, Petróleos Mexicanos plans to expand our daily production to in excess of 450,000 barrels daily by 1956. We also plan to build all the necessary pipelines and strategically located refineries to be able to supply all the future needs of Mexico with products from our own fields.

While our own technicians have directed the program of Pemex and will continue to do so in the future, we are not unmindful of the aid of the United States contract geological, seismic, and other technical organizations. Also we have recently entered into exploitation and exploration contracts with three United States independent companies. It is our intention to continue using the skill and "know-how" of United States technicians and co-operate with the United States oil industry to the full extent permitted by our laws.

I trust that this paper has served to give all of you here assembled a brief, factual account of what we are doing in the development of northeastern Mexico's oil reserves and a glimpse of our future plans. It is hoped that this discussion may help to round out the program of this industrial conference and that we may have been of some small service to our good friends.

It is with sincerest wishes for the success of the conference and the future developments of the Institute of Latin-American Studies of The University of Texas that I close this paper. Thank you very much for the opportunity here afforded me to address you.

THE OIL INDUSTRY AND RESOURCES OF TEXAS

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At the beginning of the twentieth century, the oil industry in Texas received a dramatic start toward its future expansion with the spectacular discovery of oil at Spindletop in January, 1901. In the first 48 years of the century, 260,000 wells were drilled in Texas, 28 billion barrels of oil were discovered, and approximately 13.5 billion barrels were produced. Large operations were also carried on in petroleum transportation and refining. The industry built an extensive network of nearly 40,000 miles of gathering and main pipe lines to move oil from the fields to the Gulf Coast and to the population centers of the Mid-Continent. Although the state consumes only a small part of the local production, refineries have been constructed which now process about two-thirds of the crude oil produced in Texas and constitute the principal manufacturing operation in the state. Substantial gas operations were developed incident to the production of oil. In recent years, the liquid petroleum output of the state has been increased by the operation of several hundred gas-processing plants which extract liquid hydrocarbons from natural gas.

Petroleum operations in Texas developed rather slowly in the first quarter of the century. It took the industry 17 years to find and 24 years to produce the first billion barrels of oil in Texas. About 1925, a very successful period of discovery began as a result of the application of geological and geophysical methods of exploration. Within a short time, production began to increase rapidly. Since 1928, Texas has been the principal oil-producing state in the United States. The dominant position of the state in the petroleum industry has been strengthened during the past two decades, as production here increased at a much more rapid rate than in the rest of the country.

RELATION OF THE PETROLEUM INDUSTRY IN TEXAS TO THE UNITED STATES AND WORLD IN 1948

	Petroleum Production*		Refinery Crude Runs†		Proved Oil Reserves‡ December 31, 1948	
	Million Barrels	Per Cent of World	Million Barrels	Per Cent of World	Million Barrels	Per Cent of World
Texas	974.4	27.4	599.5	19.4	14,559	18.9
Other, United States	1,187.7	33.5	1,431.2	46.3	12,262	15.9
Foreign	1,388.4	39.1	1,057.7	34.3	50,322	65.2
World	3,550.5	100.0	3,088.4	100.0	77,143	100.0

*Crude oil and natural gas liquids reported by the Bureau of Mines for the U.S. and *World Oil* for foreign countries.

†Reported by the Bureau of Mines for the U.S. and estimated for foreign areas.

‡Estimated by the American Petroleum Institute for the U.S. and by E. DeGolyer for foreign areas. (*Oil & Gas Journal*, December 30, 1948).

In 1948, Texas produced nearly one billion barrels of petroleum and refined approximately 600 million barrels of crude oil. The operations in the state represented 45 per cent of the production in the United States and 30 per cent of the refining operations. At the end of the year, proved oil reserves in Texas were nearly 55 per cent of the total in the United States and 19 per cent of the world reserves.

The leadership of the American oil industry did not come about merely by good fortune or chance. Geologists estimate that the United States has only one-sixth of the potential oil resources of the world, but the intensive search here under the stimulus of competitive enterprise has resulted in the discovery to date of as much oil in this country as in the rest of the world. The principal reason for this extraordinary success has been the large number of wells drilled by thousands of operators to test prospective areas. Even with modern scientific methods, the search for oil is a hazardous business, as evidenced by the fact that in the United States only one exploratory well in five is successful and that one-third of all the wells drilled are dry holes. Because of such hazards and the large expenditures involved in exploration, competition is the most effective method of locating the oil resources of an area.

In Texas, the search for oil has led to the drilling of 260,000 exploratory and development wells, or an average of nearly one well per square mile in the state. While there are no statistics on the number of exploratory wells drilled in the early years, it is probable that 30–40,000 wells were wildcats, as the records of recent years show that exploratory wells account for one-sixth of the total drilling. It is not surprising, therefore, that the industry has been successful in discovering a lot of oil in Texas. Similar success has been attained in adjacent states which also have large areas of sedimentary deposits where oil may have accumulated during the course of geologic time. In Texas, Louisiana, and Oklahoma, the discoveries of oil through 1948 are of the order of magnitude of 100,000 barrels per square mile of total area.

Meeting War and Postwar Demands

The outstanding recent achievement of the oil industry has been in meeting rapidly expanding demands during and after World War II. Production in Texas supplied two-thirds of the increase in domestic output between 1941 and 1948. This significant achievement during a period when oil was of utmost importance to national security was made possible only because sound conservation policies had been followed in Texas for many years prior to the war. In other words, the value of petroleum discoveries to the people of the United States was enhanced by state conservation laws which regulated production in such a manner as to prevent waste and to make more oil available when it was needed in a national emergency.

Between 1941 and 1948, it was necessary to increase petroleum production in the United States by 45 per cent, with the gain in volume equal

to that realized in the preceding 15 years from 1926 to 1941. Such an increase could not have been realized if there had not been some reserve producing capacity in 1941, especially since the shortage of steel during the war made it necessary to reduce the number of wells drilled. Fortunately, substantial reserve-producing capacity had been developed in Texas during the decade of the thirties. Consequently, petroleum production in the state could be expanded rapidly. In fact, it nearly doubled between 1941 and 1948.

PROVED PETROLEUM RESERVES AND PRODUCTION IN TEXAS ABOUT DOUBLED BETWEEN 1937 AND 1948

	Estimated Reserves* Million Bbls. on Jan. 1	Production—Million Bbls.† Crude Oil	Natural Gas Liquids	Total	Relation of Production to Reserves on Jan. 1
1937	6,422	510.3	14.7	525.0	8.2%
1938	8,248	475.9	16.3	492.2	6.0%
1939	9,448	483.5	18.4	501.9	5.3%
1940	9,768	493.2	22.2	515.4	5.3%
1941	10,624	505.6	37.1‡	542.7	5.1%
1942	10,976	483.1	37.3	520.4	4.7%
1943	11,546	594.3	39.2	633.5	5.5%
1944	11,325	746.7	44.5	791.2	7.0%
1945	11,375	754.7	52.1	806.8	7.1%
1946	11,470	760.2	54.4	814.6	7.1%
1947	13,632	820.2	62.4	882.6	6.5%
1948	13,735	903.3	71.1	974.4	7.1%
1949	14.559				

*American Petroleum Institute. The figures include natural gas liquids, estimated separately since 1944 as follows on January 1: 1946—635 million barrels, 1947—1,986 million barrels, 1948—1,957 million barrels, and 1949—2,075 million barrels.
†Bureau of Mines.
‡Revised basis, including products not previously reported.

During the war years 1942–1945, there was only a nominal increase in proved reserves in Texas, as exploratory work was slowed down by the lack of men and materials while withdrawals by production were accelerated. In the last three years, reserves have shown again a substantial gain as drilling has advanced toward the prewar levels. It is significant that in recent years the ratio of dry holes to total completions has been much higher than it was in the thirties. Therefore, the number of producing wells completed in 1948 was substantially less than the average in 1936–1938, although the total number of wells drilled was approximately the same. Considerable progress has been made during the past decade in developing oil fields with fewer wells by means of wider spacing, however, so that producing wells now may develop more reserves than the same number of wells did ten years ago.

In the twelve-year period 1937–1948, there have been drilled in Texas 105,700 wells, of which 29,600 were dry holes, 4,500 were gas wells, and 71,600 produced oil. The number of producing oil wells in the state increased by 45,200 in this same period of time, which indicates that 26,400 oil wells were abandoned because it ceased to be profitable to operate them. The wells abandoned generally have very small production of around a barrel daily. At the end of 1948 there were 112,000 producing oil wells in Texas.

WELL COMPLETIONS IN TEXAS HAVE ADVANCED TOWARD PREWAR LEVEL AFTER SHARP REDUCTION DURING WORLD WAR II

	Well Completions*				Relation of Dry Holes to Total Completions
	Oil	Gas	Dry	Total	
1937	11,030	425	2,820	14,275	19.8%
1938	8,892	341	2,577	11,810	21.8%
1939	6,683	314	2,328	9,325	25.0%
1940	6,632	289	2,173	9,094	23.9%
1941	7,258	294	2,275	9,827	23.2%
1942	3,041	186	1,461	4,688	31.2%
1943	2,373	140	1,908	4,421	43.2%
1944	3,526	268	1,935	5,729	33.8%
1945	4,036	714	2,445	7,195	34.0%
1946	4,720	499	2,585	7,804	33.1%
1947	5,814	537	2,950	9,301	31.7%
1948	7,619	542	4,090	12,251	33.4%

**Oil & Gas Journal.*

The output of the average oil well in Texas was 22.5 barrels daily last year, the highest since 1933. By comparison, the average oil well in the rest of the United States produced 9 barrels daily. The reason for the low average production per well in this country is the large number of wells drilled in developing reserves and the existence of many stripper wells that produce only a few barrels daily. In the states of Pennsylvania, New York, Ohio, and West Virginia, for example, there are 142,000 wells producing an average of less than one-half barrel daily.

The average production for all the wells in Texas conceals the wide variations between areas and fields. The daily output per well in 1948 averaged 50 barrels along the Gulf Coast, 35 barrels in West Texas, 14 barrels in the East Texas field, and only 8 barrels in North Texas. In some of the fields with large reserves, the production per well exceeded 200 barrels daily last year, whereas there were thousands of wells that did not average more than a few barrels daily.

INCREASE IN THE NUMBER OF PRODUCING OIL WELLS AND THE PRODUCTION PER WELL IN TEXAS

	Producing Oil Wells* Number on Jan. 1	Oil Production* Barrels Daily	Production Per Well† Barrels Daily
1937	66,920	1,398,100	19.4
1938	77,360	1,303,700	16.0
1939	85,600	1,324,700	15.1
1940	90,100	1,347,600	14.5
1941	95,200	1,385,100	14.2
1942	100,050	1,323,500	13.2
1943	99,800	1,628,300	16.2
1944	100,800	2,040,200	20.1
1945	102,300	2,067,800	20.0
1946	104,400	2,083,600	19.8
1947	105,900	2,247,200	21.1
1948	107,600	2,468,100	22.5
1949 Est.	112,100		

*Bureau of Mines.
†Bureau of Mines, 1937–47. Average estimated for 1948. Production per well determined by dividing daily production by the average number of wells producing during the year.

While the trend of production in the state has been upward in recent years, there have been substantial differences between the principal geographic areas. The most rapid expansion in the years 1937 to 1945 was in the Gulf Coast, whereas in the last three years West Texas and Southwest Texas have experienced the greatest increase. In 1948, West Texas was the principal producing area in the state with crude oil output of 741,000 barrels daily:

CRUDE OIL PRODUCTION BY MAJOR AREAS IN TEXAS
IN 1937, 1941, 1945, AND 1948

Thousand Barrels Daily*

	Gulf Coast	E. Cent. Texas†	Southwest Texas	West Texas	North Texas–Panhandle	Total
1937	201	580	230	205	181	1,397
1941	268	439	209	253	212	1,381
1945	519	495	335	480	237	2,066
1948	553	479	419	741	289	2,481
Change, 1937–48						
Amount	352	—101	189	536	108	1,084
Per Cent	175	— 17	82	261	60	78

*As reported by the Railroad Commission of Texas. Figures for Texas differ slightly from those of the Bureau of Mines.
†Including the East Texas field.

INCREASING IMPORTANCE OF NATURAL GAS

Another important resource developed by the oil industry is natural gas. At the end of 1948, proved natural gas reserves in Texas were 95.7 trillion cubic feet, or 55 per cent of the total in the United States. These reserves are potentially as important to the state as oil, as their heat value exceeds slightly that of the proved liquid reserves. At present, however, gas is only a small factor in the economy of the state because the price at the wells is so low. The average price received for gas by producers is approaching 5 cents a thousand cubic feet, which means a realization of only 30 cents for six thousand cubic feet, compared with $1.25 at Gulf Coast refineries for a barrel of fuel oil that has the same heat content in British Thermal Units, and with $2.65 a barrel for crude oil at wells in Texas.

A rapid expansion in demand for natural gas has occurred in recent years, principally because gas is so attractive in price relative to competitive fuels. Several large pipe lines have been built, and others are planned, to move gas from Texas to the population and industrial centers of the East, the Mid-Continent, and the Pacific Coast. The movement of natural gas out of Texas increased by 50 per cent between 1945 and 1948, but even in 1948 it represented less than one-fourth of the net production. Furthermore, large quantities of natural gas are being found and the proved reserves have increased substantially in recent years. In spite of larger production, the rate of withdrawal from the proved gas reserves in Texas continues to be around 3 per cent a year. The expansion in markets for gas from Texas is bringing about better prices that will mean greater income and additional incentive for the conservation of casinghead gas produced with oil.

NATURAL GAS RESERVES AND PRODUCTION
ARE INCREASING RAPIDLY IN TEXAS

	Proved Reserves* January 1 Billion Cubic Feet	Net Production* Billion Cubic Feet	Relation of Net Production to Reserve Jan. 1	Shipments Out of Texas† Billion Cubic Feet
1946	78,307	2,097	2.7%	451
1947	86,363	2,504	2.9%	523
1948	90,026	2,710	3.0%	625 Est.
1949	95,709	-------	---	-----

*American Gas Association.
†Bureau of Mines for 1946–47. Shipments out of the state for 1948 estimated.

CONCLUSION

The oil industry has achieved a remarkable development of the petroleum resources of the United States during the first half of the twentieth century. Those resources were made available by nature centuries ago, but only within the last century has society been able to benefit from their existence. It took great ingenuity in technology to devise methods of discovering, producing, and using petroleum on the large scale that is the basis of the modern industrial economy. Without the contribution of industrial technology, liquid hydrocarbons would still be only potential resources without much significance to modern man.

Texas has been fortunate not only in the resources underlying the soil but also in having a dynamic industry that has developed those resources to their present importance. Oil production has been carried forward so high on its growth curve that some leveling off might naturally be expected. In fact, there has recurred within recent years that concern frequently expressed in the past that the United States may be running out for oil. At least for the near future, such fears do not appear to be supported by the views of the technologists who search for oil and should be in the best position to evaluate prospective developments. Geologists are confident that large quantities of oil remain to be discovered in the United States. After careful study, a committee of the American Petroleum Institute recently estimated that under favorable economic conditions domestic petroleum production at efficient rates could be increased between 1948 and 1953 by at least 12 per cent and possibly by as much as 24 per cent. While the estimate did not include details by states, it is not unreasonable to expect that the amount of production available from Texas at maximum efficient rates will also increase at about the average rate for the United States.

The petroleum industry in Texas has made great progress since the beginning of the twentieth century. Its future for the second half of the century cannot be predicted. Judging from its dynamic nature, however, it seems safe to say that with a continuation of competitive development under favorable conditions, the trend over the next few years will be toward a further expansion of the crude oil and natural gas operations in Texas.

MEXICO'S IRRIGATION POSSIBILITIES ALONG THE NORTHEASTERN ZONE BORDERING THE STATE OF TEXAS

ANTONIO RODRÍGUEZ L.

Director General, Water Development Department, Ministry of Hydraulic Resources, Republic of Mexico

I. Foreword

Human nourishment depends upon the productive capacity of the soil, and its fertility or poorness are wholly reflected on the people devoted to its cultivation.

Water has been and will continue to be an indispensable factor in the life and economy of all nations. Therefore irrigation, or the artificial application of water to soil, is one of the means through which crops can be produced in areas where rainfall is insufficient or poorly distributed throughout the year. The harmonic combination of soil and water, if the biophysical chain that links them is considered, will produce the best crops when carefully planned. This careful planning is more necessary where these natural renewable resources are scarce.

As the water available for irrigation is rather limited in Mexico, we have had to be very careful in the devlopment of our plans, considering that irrigation is the best means to improve our agriculture.

Irrigation has been practiced in Mexico since the Aztecs. Among the works left by them I will only mention the dike built between Alzacoalco and Ixtapalapa near Mexico City by Netzahualcoyotl.

During the Spanish domination several irrigation projects were built, some very important like the Yuriria reservoir by Friar Diego de Chávez.

One hundred years after Mexico became an independent nation, some very important works were carried out for irrigation purposes, but it was the Mexican Revolution of 1910 that during its constructive period in 1926 started an intensive program along this line.

In order that the irrigation possibilities of the bordering zone of Mexico and Texas may be better understood, I believe it is advisable to analyze in a general way the broad aspects of irrigation in my country.

II. Why Irrigation Is Necessary In Mexico

a. *Climate.*

Following Lowry and Johnson's method of determining the necessity of irrigation, the total area of the country can be divided as follows:

Arid zone	1,024,818 Kms.²	52.13%
Semi-arid zone	600,776 Kms.²	30.56%
Semi-humid zone	206,812 Kms.²	10.52%
Humid zone	133,484 Kms.²	6.79%
	1,965,890 Kms.²	100.00%
	(759,030.10 sq. miles)	

From the above data we can see that 93 per cent of the total area of Mexico needs full or partial irrigation.

Desert lands in northern Mexico.

b. *Water available.*

Our Director of Hydrology has divided the country into great hydrographical regions, taking into account the geographical and topographical aspects, the movements of air masses, and available rainfall data. They have determined the volume of water received by Mexico according to the following table:

Region	Zones within every Region	Area in Km.^{2}	Rainfall in MM.	Volume of Rainfall—Millions of M^3
Eastern	Yucatán and Gulf of Mexico coasts.	727,000	1,050	763,000
Western and Southern	Coasts of Sonora, Sinaloa, Nayarit, Jalisco, and Colima States Coasts of Michoacán, Guerrero, Oaxaca, and Chiapas States.	896,000	690	614,000
High Plateau	Northern and Southern zones.	334,000	430	143,300
	TOTAL	1,957,000	723 (mean)	1,520,300
		(755,597.7 square miles)	28.4″ (mean)	(1,231,443 (th. acre ft.)

(The total area reported in this table is slightly different from that reported in the table above.)

The average volume of water precipitation all over the Republic of Mexico is 1,520,300 millions of cubic meters (1,231,443 thousands of acre feet).

After natural needs of water (evapotranspiration) are supplied, another portion of water is percolated through the soil, and the rest flows as surface run off forming rivers and creeks.

The 452 existing hydrometric stations make it possible to gauge the flow of streams whose basins drain an area of about 40 per cent of the total area of the country. By using the data of existing stations and making an estimate for the rest (considering rainfall data, run off coefficients, and a proper criterion), the Hydrology Department has obtained the following results:

Regions	Millions of M^3 Volume of Rainfall	Volume of Run Off	Run Off Percentage
Eastern	763,000	119,600	15.6%
Western & Southern	614,000	58,200	9.5%
High Plateau	143,300	3,600	2.5%
TOTALS	1,520,300 (1,231,443 th. of acre ft.)	181,400 (146,934 th. of acre ft.)	12.0%

The estimated rainfall volume can be distributed as follows:

	Millions of M^3	
Evapotranspiration and underground water	1,338,900	88%
Run off or surface water	181,400	12%
	1,520,300	100%

Roughly speaking the above 88 per cent could be divided as 63 per cent for evapotranspiration and 23 per cent for underground water.

For an adequate planning of water development it is necessary to consider climatological, geological, topographical, and economic limitations. Estimates have been made whereby the 80 per cent of 181,400 millions of M^3 of surface water available can be utilized. Of the 350,00 millions of M^3 (23 per cent of rainfall) of underground water, only about 5 per cent could be developed.

c. *Soils.*

According to Mr. Alfonso Contreras Árias, distinguished Mexican meteorologist, the total area of Mexico could be classified as follows:

Arable lands	23,400,000 hects.	11.9%
Pasture lands in flat and rolling country	66,500,000 hects.	33.9%
Pasture lands in hilly or mountainous country	30,000,000 hects.	15.3%
Forestry lands	45,000,000 hects.	22.9%
Desert lands	31,500,000 hects.	16.0%
Total area of our country	196,400,000 hects. (485,304,400 million acres)	100.0%

As to the quality of soils prevailing in Mexico we can say that according to the world classification they are known as: Chestnut, Chernozem, Prairie Yellow and Red Lateritic, and Rendzina. In most of our soils clay predominates, which is a rather unfavorable characteristic. From the point of view of other chemical components, Mexican soils in general are abundant in calcium and potassium but lack nitrogen, phosphorous, and magnesium. The determining factor for soil fertility being nitrogen, the result of these characteristics is likewise unfavorable to our soils.

Corn cultivated in the Rio Mante Irrigation District, State of Tamaulipas.

d. *General Irrigation Possibilities.*

From studies made by the Ministry of Hydraulic Resources it has been estimated that by utilizing 80 per cent of the average stream flow by means of storage dams, about 6,800,000 hectares (some 16,802,800 acres) could be irrigated. If we add to this figure the areas that could

be irrigated with underground water and about 2,000,000 hectares (about 5 million acres) of arable land in the humid regions, we would obtain about 10 million hectares (24.71 million acres) of land with assured water supply. The rest, excepting the 23.4 million hectares (57.8 million acres), would be condemned to rely on uncertain rainfall. The area with assured water supply would mean 0.4 hectares (about 1.00 acre) per inhabitant for a population of 25 million people (Mexico now has approximately 23 million inhabitants). Cultivation of the 23.4 million hectares of arable land would mean an area of 0.93 hectares per inhabitant which is a figure much lower than the area under cultivation in the United States, which is 1.2 hectares (about 3 acres) per inhabitant.

Of course, all the above figures can be considered only as approximate, according to the accuracy of studies thus far made. From the results of these studies Mexico has outlined its hydraulic policy as follows:

1. All water available in arid, semi-arid, and semi-humid zones should be used in its totality to develop the largest irrigation area possible, previously utilizing the same water in developing as much power as possible.

2. In humid regions that do not require irrigation or need it only as a help, preference should be given to the development of power and flood control.

As a result of this policy irrigation projects have been developed by the Mexican Government for the benefit of the following areas:

Irrigated area existing up to 1910 (before the present irrigation policy was started)	700,000 hectares (1,729,700 acres)
Irrigated area opened as the result of projects finished from 1926 to 1946	816,224 hectares (2,016,889 acres)
Irrigated area benefited by irrigation projects finished in 1947	120,307 hectares (292,278 acres)
Irrigated area opened in 1948 (preliminary estimates)	135,542 hectares (334,924 aeres)

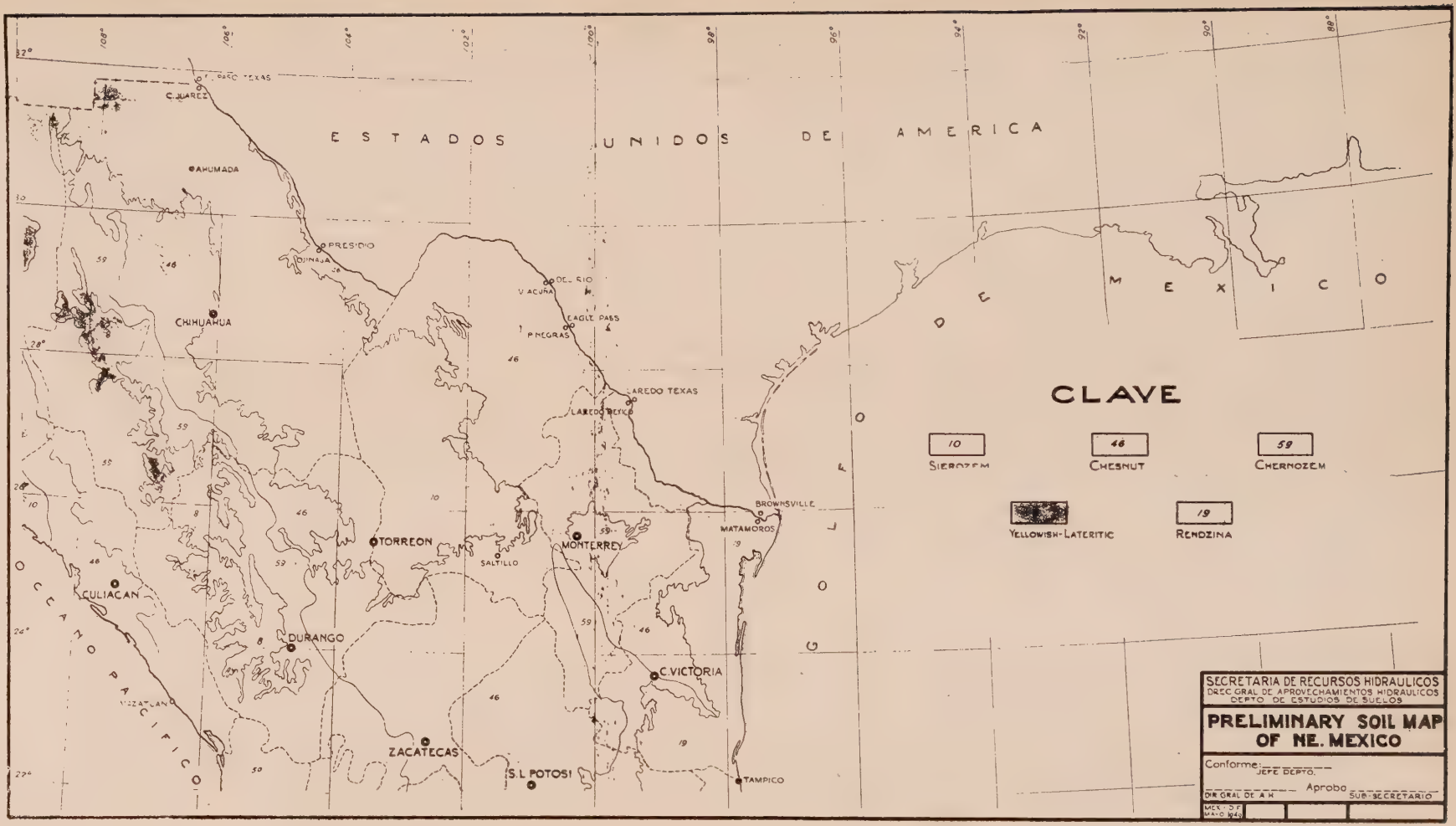
President Alemán's irrigation program (1947–1952) includes projects to irrigate approximately one million hectares (2,471,000 acres) with a cost of about 1,500 million pesos.

III. THE NORTHEASTERN REGION OF MEXICO BORDERING THE STATE OF TEXAS.

In the following chapters I will try to present a general analysis of irrigation on the following aspects: climate, soils, available water, irrigation possibilities, and some human aspects of the problem.

a. *Climate.*

If we consider the general zonal classification of Mexico already mentioned, the border zone would fall within the arid and semi-arid region.


ESTADOS UNIDOS DE AMERICA
GOLFO DE MEXICO
OCEANO PACIFICO
C. JUAREZ
PASO TEXAS
AHUMADA
PRESIDIO
OJINAGA
DEL RIO
V. ACUÑA
EAGLE PASS
P. NEGRAS
CHIHUAHUA
LAREDO TEXAS
LAREDO MEXICO
BROWNSVILLE
MATAMOROS
TORREON
SALTILLO
MONTERREY
CULIACAN
DURANGO
C. VICTORIA
MAZATLAN
ZACATECAS
S. L. POTOSI
TAMPICO
CLAVE
10 SIEROZEM
46 CHESTNUT
59 CHERNOZEM
YELLOWISH-LATERITIC
19 RENDZINA
SECRETARIA DE RECURSOS HIDRAULICOS
DIREC. GRAL. DE APROVECHAMIENTOS HIDRAULICOS
DEPTO. DE ESTUDIOS DE SUELOS
PRELIMINARY SOIL MAP OF NE. MEXICO
Conforme: JEFE DEPTO.
Aprobo
DIR. GRAL. DE A. H.
SUB-SECRETARIO
MEX. D.F. MAYO 1946

For a more detailed study of the climate, a map for this zone has been prepared following the Thornthwaite method. Alfonso Contreras Árias' climate chart was utilized and completed with data from agrological studies made by the Soil Survey Department of the Ministry of Hydraulic Resources.

The zone is about 2000 kms. (1,242 miles) in length along the Rio Bravo (Grande), and its climatic variation is due to the following factors:

Geographical location. The zone is located between the warm waters of the Gulf of Mexico and the mountainous region of the Western Sierra Madre and the counterforts of the Eastern Sierra Madre.

Elevation. The orographic landscape is variable. It comprises an ample coastal plain in Tamaulipas from Camargo to Matamoros, 100 kms. (62 miles) deep toward the south; a region of rolling country from Camargo to Nuevo Laredo; and a more hilly zone from there to Juárez with extensive plains to the south of this point. Differences in altitude run from 10 to 1,146 meters (33 to 3,760 feet) above sea level.

One of the main climatic characteristics of this zone is the existence of low percentages of relative humidity and high percentages of insolation even in the more rainy portions. These characteristics make the climate healthful and favorable for agricultural production and cattle raising where there is enough water available during the dry season. Irrigation is necessary all over this zone.

Temperature. Maximum temperature varies from 38.5°C (101.3°F) in Chihuahua City to 49°C (120.2°F) in Múzquiz, Coahuila. Absolute minimum temperature corresponds to Juárez City with –16°C (3.2°F). Minimum temperature in all the zone varies from –5°C (23°F to –16°C (3.2°F). Mean temperature is fairly uniform between Matamoros and Múzquiz, varying from 21.3°C to 22.6°C (70.3° to 72.7°F); the coldest zone corresponds to the state of Chihuahua with a mean temperature which varies from 16.9° to 18.1°C (62.4° to 64.6°F).

Frosts. A very noticeable change occurs in the frost-free period in the zone we are considering. A maximum difference of 124 days exists between the growing period in Matamoros and Juárez. Between Camargo and Matamoros, Tamaulipas, the growing period varies from 309 to 330 days; between Camargo and Nuevo Laredo, Tamaulipas, the growth period is reduced by 20 days, and it keeps reducing as we approach Juárez, where it reaches a minimum of 200 days.

Rainfall. Rainfall varies between 694 mm. (27.1″) in Matamoros and 210 mm. (8.2″) in the City of Juárez. Within the zone there exist small areas of greater rainfall du to the relief microclimatic rains. Thus, in Linares, State of Nuevo León, Monterrey, Nuevo León, and Múzquiz, Coahuila, rainfall is 800, 714, and 702 mm. (31.2″, 27.8″, 27.3″) respectively.

With data from 28 weather stations climate characteristics were calculated following Thornthwaite's method, thus completing Alfonso Contreras chart, as indicated.

Starting from Matamoros upward to Juárez, the following climateric zones were determined:

Zone	Location	Climate Notation	Interpretation	Possible Crops
I	Zone located near the Gulf of Mexico	C(r)B'$_1$(b')	Semi-dry without well defined dry period; semi-warm with mild winter; humid winds and breezes.	A great variety of crops can be grown: cotton, corn, peanut, citrus trees, sesame, truck crops. Alluvial rich soils.
II	Zone neighbouring the coastal plains	D(o)A'(b')	Dry climate. Rainfall is scarce in summer; hot with mild winter. Variable topography.	Cotton, beans, corn, sesame, truck crops.
III	Small zone located in counterfort of Eastern Sierra Madre.	C(r)B'$_1$(b')	Semi-dry and semi-warm climate with mild winter.	Citrus, corn, barley, sorghum, truck crops, etc.
IV	Zone located to the south of zone III.	C(r)B'$_1$(c')	Similar to zone III but more variable temperatures prevail in summer and winter.	Citrus, corn, pecan, trees, etc.
V	Zone around Múzquiz, Coah.	C(r)B'$_1$(c')	Semi-dry; semi-warm and variable climate.	Same as zone IV.
VI	Big zone including almost all portion of D. Martín Irrigation District.	D(r)B'$_1$(c')	Dry climate; dry season not well defined; semi-warm and variable.	Grapes, wheat, cotton, beans, corn. Fruit trees like peaches, pears, and quince. This zone includes the rich Laguna District.
VII	Neighbouring dessert zone.	E(ip)B'$_1$(c')	Very dry; winter and spring dry; semi-warm and variable.	Rich soils if irrigated. Cotton, wheat, alfalfa, grapes, truck crops, etc.
VIII	Zone located to the north of zone VII.	E(ip)B'$_2$(c')	Very dry; winter, and spring, and summer dry and variable.	Wheat, corn, beans, apple trees. Cattle country. Forestry is very important.

Zonal tables with weather data are presented on pages 148–156.

b. *Soils.*

A preliminary soil classification map of northeastern Mexico is presented. Soils are classified according to big soil groups of the world.

In this zone sierozem and chestnut soils predominate; relatively small zones of chernozem and rendzina soils are found.

ESTADOS UNIDOS DE AMERICA
GOLFO DE MEXICO
OCEANO PACIFICO
GUATEMALA
PR RODRIGUEZ
RIO COLORADO
C JUAREZ
PR STA TERESA
LA ANGOSTURA
PR F VILLA
SN BUENAVENTURA
PRESA HERMOSILLO
HERMOSILLO
RIO YAQUI
PR ALVARO OBREGON
C DELICIAS
PR CAMOA
RIO MAYO
RIO FUERTE
PR SINALOA
PR L CARDENAS
CULIACAN
SN LORENZO
LA PAZ
EL TUNAL
PR TRUJILLO
LAS VACAS
SN CARLOS
EL NOGAL
DON MARTIN
PR M R GOMEZ
R LAGUNERA
MONTERREY
SALTILLO
LAS LAJAS
RIO BRAVO
RIO PURIFICACION
STA ENGRACIA
RIO FRIO
XICOTENCATL
EL VANTE
ZACATECAS
TLALTENANGO
SANTIAGO
MAGDALENA Y AHUALULCO
CUARENTA
CA SALAMANCA
LA GOLONDRINA
LA PIEDAD
ZAMORA
L METZTITLAN
IXMIQUILPAN Y ZAPATA
ALTO LERMA
M DE LA TORRE
P TACOTAN
COLEGIO AMATLAN
TULA
AUTLAN
ZACAPU
SOLIS
MORELIA Y QUERENDARO
LA ANTIGUA
COLIMA
TEXCOCO
TIERRA CALIENTE
ARMERA
COAHUAYANA
EL RODEO
VALSEQUILLO
CUTZAMALA
CHILPANCINGO
OMETEPEC
PINOTEPA
TEHUANTEPEC
MARQUES
GOLFO DE TEHUANTEPEC
MERIDA
CAMPECHE
TUXTLAS
IRRIGATION PROJECTS IN MEXICO
Irrigation Districts under study
" " " construction
" in operation
1948

The portion of the State of Chihuahua shown on the map belongs to sierozem soils predominantly; in the State of Coahuila, chestnut and sierozem soils prevail; in Nuevo León and Tamaulipas, chestnut and some rendzina soils predominate.

Soil groups of this zone belong to the calcification process of soil formation as described by Dr. Charles E. Kellogg. This process is mainly developed in regions with low or medium rainfall and low vegetation.

According to a soil survey made by our Soil Department, the agricultural soils of the zone included in this study have the following general characteristics:

Region	Predominant Soil Series	Characteristics of Predominant Soil Series	Possible Crops
Matamoros-Camargo	Alluvial soils with flat to rolling topography; deep and well drained. Primary soils are found in the southern portion. Predominant series: Camino, cuevas, López and Rio Grande; Badly drained series: Base and Luz.	*Rio Grande series:* Rich soils with much lime. Good drainage in light profiles. Fair to bad drainage in heavy profiles. Good fertility pH 7.5 to 8.00. *Luz series:* Soils with bad drainage. Gypsum is present in the subsoil. Artificial drainage necessary.	Cotton, corn, citrus trees, sesame, truck crops.
Camargo-Laredo	Deep soils are found between Rio Bravo and the hills. Shallow soils in the hills. In the plateaus and valleys, the Laredo, D. Martín and Tapón series predominate.	*Laredo series:* Deep and light profile. Alluvial soils rich in lime and plant nutrients; low in organic matter. *D. Martín series:* Highlands very limy; deep and well drained subsoils.	Cotton, corn, fruit trees, and truck crops in the Laredo series. Cotton, sesame, flax, sorghum and truck crops in the D. Martín series.
Laredo-Villa Acuña	Agricutural soils are alluvial and rich in lime. In the hills Reforma series is extensive and also in the previous zone. Soils of lower places are deep and with variable profile. Reforma, Vega (Rio Grande) and Victoria series prevail.	*Victoria series:* Soils rich in lime and well drained. *Vega series:* Alluvial soils well drained and with uniform profiles.	For Highlands: corn, wheat. Vega series: Cotton, corn, cantaloupe, watermelon, truck crops.
Around Juárez City	Agricultural lands correspond to alluvial soils deposited over geological formations of the Valley. At less than one meter layers of sand are found. All of the soils have white alkali. Series: Rio Grande, Zaragoza and Porvenir. Soils to the south towards Chihuahua City are typical of the desert.	*Rio Grande series:* Light profiles with alternate sand layers. Light phase of the series. All the profile has white alkali but due to light texture and good drainage salts are easy to eliminate.	Cotton, grapes, alfalfa, truck crops.

ESTADOS UNIDOS DE AMERICA
GOLFO DE MEXICO
E(i.DV) B'₁(c')
D(ip) B'₁(c')
CHIHUAHUA
E(ip) B'₁(c')
C. CAMARGO
D(r) B (c)
B(r) C'(c')
B(r) C'(c')
C(ip) C'(c')
B(r) C'(c')
D(ip) B'₂(c')
B(p) B'₂(c')
D(i.p) B'₁(c')
SALTILLO
MONTERREY
D(o) A'(b)
CAMARGO
MATAMOROS
C(r) B'₁(b')
C(r) B'₁(c')
SECRETARIA DE RECURSOS HIDRAULICOS
DIREC. GRAL DE APROVECHAMIENTOS HIDRAULICOS
DEPTO. DE ESTUDIOS DE SUELOS
MAP SHOWING CLIMATE OF NE. PORTION OF MEXICO BORDERING THE STATE OF TEXAS, U.S.A.
THE THORNTHWAITE METHOD OF CLIMATE CLASSIFICATION WAS USED
Conforme
JEFE DEPTO.
Aprobó
DIR. GRAL DE APROVS. H.
SUB-SECRETARIO
MEXICO, D.F.
MAYO - 1949

e. *Available water.*

The geopraphical and climatological data show that irrigation is necessary in all the northeastern zone of Mexico bordering Texas. The need of irrigation becomes more imperative from Matamoros toward the City of Juárez. Water is the limiting factor, since there are great areas of arable land in the region. For the irrigation of the zone, surface and underground waters have to be considered.

Surface Water. The bordering zone of Mexico with Texas includes all the Rio Grande basin within Mexican territory, a great desert portion in the states of Chihuahua and Coahuila and a portion of the Tamaulipas coastal plain south to the San Fernando River. This vast area can count only with the Rio Grande tributaries and the Rio Grande itself for irrigation.

Don Martín Irrigation District, Coah., N.L. "Venustiano Carranza" Dam.

The following estimates and data, presented in extracted form, were taken from the hydrological studies made jointly by the Mexican section of the International Water and Boundary Commission and the National Irrigation Commission, the report of Mr. Adolfo Orive Alba, C. E., now Secretary of Hydraulic Resources, and an article relating to the International Water Treaty between the United States and Mexico, published in 1945.

The Rio Bravo (Rio Grande) has its origin in the southern part of the State of Colorado. In the United States it runs south until it reaches Juárez City, where it changes the direction of its course towards the east. From that point and all along its course down to its outlet in the Gulf of Mexico, the river forms the international boundary between the United

States and Mexico for about 2,000 kilometers (1,242 miles). From Fort Quitman to the Gulf of Mexico the basin of this river in the United States has an area of 150,528 kms.^{2} (58,118 square miles) and includes parts of New Mexico and Texas.

The main American tributaries of the Rio Bravo (Grande) are the Pecos and Devils rivers, Goodenough Springs, and the Alamito, Terlingua, San Felipe, and El Pinto creeks.

The Rio Bravo basin in Mexican territory from Fort Quitman to the Gulf has an area of 211,177 square kilometers (81,535.4 square miles) including parts of the states of Chihuahua, Coahuila, Durango, Nuevo León, and Tamaulipas.

The main Mexican tributaries are the Mexican Conchos River, the Las Vacas Creek, and the San Diego, San Rodrigo, Escondido, Salado, Álamo, and San Juan rivers.

If no water were utilized on either side, the following approximate volumes would be discharged in the Rio Bravo (Grande) from Fort Quitman to the Gulf:

Originated in Mexico	5,812 million M^3 (4,707,720 acre-feet)	(65%)
Originated in U. S. A.	3,047 million M^3 (2,468,070 acre-feet)	(35%)
Total	8,859 million M^3 (7,175,790 acre-feet)	100%

When both countries have made or completed all foreseen water developments of the Rio Bravo tributaries within their own territories, the mean annual discharges to the Rio Bravo between Fort Quitman and its outlet in the Gulf of Mexico would be approximately as follows:

From Mexico	2,894 million M^3 (2,344,140 acre-feet)	(58%)
From the U. S. A.	2,059 million M^3 (1,667,790 acre-feet)	(42%)
Total	4,953 million M^3 (4,011,930 acre-feet)	100%

The above approximate volumes would arrive in great short-lasting floods. The discharge of the Rio Bravo during the dry season is so small that it is not sufficient for irrigation needs on both sides of the border. From this fact we can realize the enormous importance of international storage dams.

In the table below the data relative to unaltered flow characteristics (river regime), present and future, approximate uses and probable surplus of the Rio Bravo in millions of M^3 are as follows:

THIS TABLE IS BASED ON DATA FROM 1910 TO 1943

Origin	Virgin Discharge	Uses Present	Uses Future	Surplus	
From Mexico:					
1. Conchos River	2,045	843	1,275	770	
2. Las Vegas Creek, San Diego, San Rodrigo, Escondido rivers	418	106	128	290	
3. Salado River	925	562	562	363	
I. Sum for 6 tributaries	3,388	1,511	1,965	1,423	
II. Alamo & San Juan rivers	1,557	372	953	604	
III. 50% Direct basin	867*			867	
Total from Mexico (65%)	5,812	1,883	2,918	2,894	58%
Acre-feet	4,707,720	1,525,330	2,363,580	2,344,140	
From the U. S. A.					
I. Pecos and Devils rivers, Goodenough Springs, Terlinga, Alamite, S. Fernando and Pinto creeks	2,180	988	988	1,192	
II. 50% Direct basin	867	†		867	
Total from U. S. A. (35%)	3,047	988	988	2,059	42%
Acre-feet	2,468,070	800,280	800,280	1,667,790	
TOTAL RIO BRAVO (100%)	8,859			4,953	100%
Acre-feet	7,175,790			4,011,930	

*The mean annual volume of 265 millions of M^3 that passes through Fort Quitman is included in this table. This volume will be distributed in half for both countries.

†Present uses of 1,419 millions of M^3 in agricultural zone of Brownsville, Texas, are not included.

The areas irrigated in Mexico up to 1943 (before the treaty) and possible future developments are as follows:

River or Tributary	Irrigated Area up to 1943	Developments Contemplated	Future Irrigable Area
Conchos River	73,200	42,700	115,900 hectares
Las Vacas Creek	240	460	700 hectares
San Diego River	8,500	2,000	10,500 hectares
San Rodrigo River	2,250	630	3,180 hectares
Escondido River	3,900		3,900 hectares
Salado River	54,880		54,880 hectares
Alamo River	3,100	7,500	10,600 hectares
San Juan River	55,080	60,600	115,680 hectares
	201,150	113,890	315,340 hectares
Acre-feet	497,782.9	281,422.2	779,205.1

Due to the nature of problems involved in water distribution of the Colorado, Tijuana, and Rio Bravo (Grande) rivers, international negotiations for a settlement were initiated. After the 1906 treaty, which regulated the delivery of water to Mexico for irrigation purposes along the Juárez valley down to Fort Quitman, Texas, the two countries agreed in 1927 to carry out a series of talks about this subject which took place in 1928 and were continued in 1929. After several interruptions, in 1933 an agreement for the recitification of the Rio Bravo bed in the Juárez

valley was signed. Later on, after arduous negotiations, consistently guided by a spirit of open cordiality and friendly co-operation, a treaty was signed on February 3, 1944, which became effective on November 8, 1945.

The following table gives the figures concerning the distribution of possible surplus water according to the treaty.

TO MEXICO

(Figures in millions of M^3)

1. ⅔ of surplus of the Conchos River, Las Vacas Creek, San Diego, San Rodrigo, Escondido, and Salado rivers	949
2. ½ of surplus from direct Mexican basins	434
3. ½ of surplus from direct American basin	433
4. All the surplus from the Alamo and San Juan rivers	604
	2,420
	(1,960,200 acre-feet)

TO THE UNITED STATES OF AMERICA

1. ⅓ of surplus from the Conchos River, Las Vacas Creek, San Diego, San Rodrigo, Escondido, and Salado rivers	474
2. All the surplus from the Pecos and Devils Rivers, Goodenough Springs, Alamito, Terlingua, San Felipe, and Pinto creeks	1,192
3. ½ of surplus from direct Mexican basin	433
4. ½ of surplus of direct American basin	434
	2,533
	(2,051,730 acre-feet)

SUMMARY

To Mexico	2,420	(49%)
To the U. S. A.	2,533	(51%)
Total	4,953	(100%)
	(4,041,930 acre-feet)	

Article 5 of the Treaty binds the governments of the two countries to build in the main river bed of the Rio Bravo (Grande):

I. Dams as required for the storage and regulation of the greatest possible portion of the annual flow of the river in such a form as to insure the present water uses and to make possible the development of the greatest number of projects, within the limitations imposed by water distribution herein stipulated.

II. Dams and other common works as required for diversion of water from the Rio Bravo (Grande).*

The same mentioned article indicates that construction work shall start at the lower main storage dam which has to be completed within eight years from the date the treaty became effective.

*Translation from the Spanish version by the author.

Work on the great international Falcón Dam has been started already. This structure will have the following general features:

Total capacity	4,070 million M^3 (3,296,700 acre-feet)
Type	Earth fill dam.

This dam will permit the irrigation of 220,000 hectares (543,620 acres).

Numerous creeks like Las Vacas are tributaries to the Rio Bravo. They are not considered in the hydrological studies due to their small importance and lack of data.

The irrigation projects constructed or under construction by the Mexican Government up to the present time are as follows:

Large Irrigation Projects:

River	Irrigation Districts	Present Area Under Irrigation—Hects.	Future Irrigable Area—Hects.
Conchos River	Conchos District, Chih.	39,703	70,000
Rio Bravo	Juárez District, Chih.	15,000	15,000
San Diego River	Palestina District, Coah.	10,600	10,600
Salado River	Don Martín District, Coah. & N. L.	30,000	30,000
San Juan River	Lower S. Juan Dist., Tamps.	36,145	66,000
Las Lajas	Las Lajas, N. L.	3,100	3,100
Rio Bravo	Lower Rio Bravo Dist., Tamps.	45,000	220,000*

*Including area irrigated with International Dam.

Small Projects:

Built by the Ministry of Hydraulic Resources with the co-operation of each State as mentioned below.

State	River or Creek	Irrigable area
COAHUILA:		
(T) Las Vacas	Las Vacas Creek	540
(C) Villa Fuentes	Escondido River	1,680
(T) Jiménez	Toritos Creek	150
(T) Sta. Gertrudis	Nadadores River	660
(C) Jalapa	San Miguel Creek	1,225
(E) San Rodrigo	San Rodrigo River	2,000
(T) Guadalupe Victoria	Sabinas River	600
		6,855
NUEVO LEON:		
(C) Rio Candela	Candela River	2,500
(T) El Potosí	El Potosí Springs	400
(T) La Ermita (1st unit)	San Vicente Creek	100
(T) El Alamo	El Alamo Creek	300
(C) Lagunita de Castillo		400
(T) Marín	Ramos Creek	650
(T) Maicillos (1st unit)	Mojarras River	50
(E) Hualahuises	Hualahuises River	570
(E) Rancho viejo	Ramos River	750
(T) Tortuga	Patos River	400
(T) S. Nicholás de las Garzas	Drainage water from the City of Monterrey	810
		6,930

Legend for abbreviations:
(E) Study
(C) Project under construction
(T) Construction finished

The difference between the areas shown in the above tabulation and those appearing in the table indicating present uses up to 1943 corresponds to areas that are being irrigated with projects built by the Ministry of Hydraulic Resources from 1943 to 1948, especially in the Lower San Juan District and also to areas that have been under irrigation for a long time with works constructed by water users directly and through concessions by the government granted under existing water laws.

As Ing. Páez Urquidi, Executive of the Federal Electrical Commission, is going to discuss the hydroelectrical aspects, I will only say that all irrigation works in Mexico are planned having primarily in mind the public's interest, and therefore their design and integral development are based on the total use of available resources or multiple use of said works.

As an example I will mention the following hydroelectric plants that have been built or are planned for this northeastern zone of Mexico:

Francisco I. Madero Dam, in the Conchos Irrigation District. This plant has been designed for a total installed capacity of	5,000 KW
Mean annual production	23 million KWH
In the same district mentioned above there exists the 105 K. plant with:	
Installed capacity of	2,000 KW
Mean annual production	8.5 million KWH
Falcón International Dam in the Rio Bravo Irrigation District. With the two higher dams which are to be built, Mexico will be able to utilize in the two plants:	
Installed capacity	63,000 KW
Mean annual production	250 million KWH
Salinillas Dam in Don Martín District	500 KW (mean)

Underground Water.

Unfortunately the geohydrological studies are very few regarding this zone, and therefore we cannot present in an adequate form the possibilities of irrigation with underground water.

In the Laguna District in the states of Coahuila and Durango a big zone about 80,000 hectares (197,680 acres) is irrigated with underground water. Wells are being drilled in the Bermejillo valley in the north, and this zone might be extended further in a northeastern direction.

Some wells have been drilled successfully in the Juárez valley.

According to data from our Geological Department, favorable conditions exist for irrigation by pumping in the Juárez valley. In the Jiménez, Chihuahua zone, and in the Casas Grandes, Chihuahua region. There are some possibilities in the Ojinaga region, and favorable conditions exist for underground water in the Rio San Juan region in the State of Tamaulipas.

No geohydrological studies have been made by our Department in the rest of the border region, although they will soon be initiated and intensified. However, it looks as though there is enough underground water in the great cattle regions of the states of Chihuahua and Coahuila to serve for stock raising.

IV. Some Human Aspects of Irrigation of the Border Region.

By 1930 a good portion of some of the irrigation projects was ready to be opened for cultivation. Therefore, the problem of populating these projects arose. This problem is difficult under any conditions, but the absence of any experience in the settlement of irrigation districts made the problem appear still harder. It was necessary to adopt measures never before experienced and to take other special steps. Some of these measures and regulations had to be actually tested in the field, adapted to social and economic conditions of the region, and an effort had to be made to obtain the best results out of the laboratory rules. All these measures and regulations had, as it was to be expected, their alternatives of success and failure.

In the northern irrigation districts, where agriculture was practically impossible without irrigation, it was relatively easy to design an adequate plan of land subdivision, with roads which enabled the farmers to reach their parcels; a secondary system for easy irrigation; a system of property lines and units not crossed by roads, canals, or drains.

Preparing land for cultivation in Lower Rio Bravo Irrigation District.

The organization, settlement, and operation of irrigation districts built in the zone considered in this paper was done under the irrigation law of 1926 in force until 1946 when the new law was issued.

At the beginning, the settlement of the Don Martín and Conchos projects (the two more important developed in the zone under the 1926 law) was slow; applicants seemed not very anxious to go to the irrigated lands. Very soon, however, four or five years after the opening, the demand for land grew in such form that it was necessary to reduce the maximum areas adjudicable.

In the irrigation districts that are being developed at the present time, the demand for land is so great that it cannot be met with the land available.

In the Lower Rio Bravo District we have started to settle farmers brought from over-populated regions of the country and located beside

Conchos River Irrigation District "Francisco I. Madero" (Las Virgenes) Dam.

the local people, since one of the main objectives of our irrigation policy is to obtain a better distribution of our rural population.

As far as repayment of cost of irrigation works is concerned under the 1926 law, the irrigation fees were fixed from $70.00 to $260.00 per hectare, considering the capacity of settlers to meet obligations. This fee represented from 10 to 37.2 per cent of the total unit cost of irrigation.

The new 1946 law established new rules for the fixing of irrigation fees. The present ones have been fixed at from $500.00 to $700.00 per hectare, and they represent 33 to 46 per cent of present unit cost of the irrigation works.

Crop value per hectare has varied from an everage $192.50/hectare in 1935 to $630.00/hectare in 1945 and $840.00/hectare in 1948.

Naturally, to fully estimate these figures, changes of rate of exchange have to be considered.

In the Lower Rio Bravo District last year and during the present year, crops have had values amounting up to 300 million pesos, considering irrigated and dry farming crops. The zone has been completely transformed during the last ten years. The woods have been replaced by enormous cultivated fields and the shacks by modern homes.

Under the necessary limitations of this paper it is not possible to analyze in detail the different aspects of irrigation in northeastern Mexico, such as the physical, economic, and social aspects. But I hope that the general presentation of this problem, as made, will enable the audience to realize the importance of the enormous effort of the Government of Mexico for the betterment of its rural masses, crowned by success not only from the technical point of view, but in its economic and social results.

ESTADO DE TAMAULIPAS. ZONA No.1

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE 1871 - 1940

Brownsville Tex.- Frente a Matamoros, Tamps.

214-7

MESES Months.		°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i)' DE EFICIENCIA DE LA TEMPERATURA	mm. (Rainfall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 1917 --	TOTAL EN EL AÑO MAS HUMEDO 1887	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE	D	16.3	33.9	-7.8	5.98	40.3	8.1	123.9	2.41
ENERO	J	15.4	32.2	-7.8	5.49	35.2	7.1	5.6	2.15
FEBRERO	F	17.2	34.4	-11.1	6.49	32.2	5.1	17.3	1.81
INVIERNO		16.3	34.4	-11.1	17.96	107.7	20.3	146.5	6.37
MARZO	M	20.1	38.9	- 1.1	8.22	30.9	38.3	72.8	1.56
ABRIL	A	23.2	37.7	3.8	10.21	35.5	10.9	1.8	1.66
MAYO	M	25.8	38.9	5.0	11.99	60.9	65.2	100.0	2.78
PRIMAVERA		23.0	38.9	- 1.1	30.42	127.3	114.4	174.6	6.00
JUNIO	J	27.9	39.3	13.3	13.50	65.4	18.0	350.2	2.82
JULIO	J	28.7	38.9	13.9	14.09	48.9	114.7	8.4	2.00
AGOSTO	A	28.8	40.0	17.2	14.17	61.6	7.4	36.8	2.64
VERANO		28.4	40.0	13.3	41.76	175.9	140.1	395.4	7.46
SEPTIEMBRE	S	25.9	38.9	10.6	12.06	147.4	26.1	346.4	7.37
OCTUBRE	O	23.8	37.2	3.3	10.62	83.5	Inap.	412.9	4.17
NOVIEMBRE	N	19.6	36.7	- 2.8	7.91	52.0	7.4	42.4	2.83
OTOÑO		22.9	38.9	- 2.8	30.59	282.9	33.5	801.7	14.37
ANUALES		22.6	40.0	-11.1		693.8	308.3	1518.2	
Indice anual de eficiencia de la temperatura					120.73				
Indice anual I de precipitación efectiva									34.20
% de concentración térmica en el verano					34.59				

CLIMA DE ACUERDO CON THORNTWAITHE C (r) B$_1$ (c')

C= Semi-seco, (r)= Sin estación seca bien definida.
B$_1$= Semi-cálido, (c')= Con invierno benigno.

ESTADO DE TAMAULIPAS. ZONA NORTE

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE 1931 - 39.

Nuevo Laredo, Tampa.

214-7

MESES Months	°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i) DE EFICIENCIA DE LA TEMPERATURA	mm. Pointfall PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO (Fecha)	TOTAL EN EL AÑO MAS HUMEDO (Fecha)	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE D	19.98	37.2	0	8.16	36.35	69.5	58.7	1.91
ENERO J	17.76	37.5	5.2	6.84	31.50	5.6	114.2	1.75
FEBRERO F	19.94	36.5	0	8.10	17.42	4.4	25.4	0.85
INVIERNO	19.23	37.5	0	23.10	85.27	79.5	198.3	4.51
MARZO M	22.20	36.8	5.0	9.55	14.54	11.7	26.9	0.64
ABRIL A	25.40	38.6	3.0	11.71	27.41	Inap.	10.0	1.15
MAYO M	29.17	39.2	12.1	14.47	76.60	16.6	216.2	3.25
PRIMAVERA	25.59	39.2	3.0	35.73	118.55	28.3	253.1	5.04
JUNIO J	32.17	42.5	18.1	16.78	46.82	0.2	38.7	1.75
JULIO J	33.62	43.1	18.5	17.89	45.50	16.2	112.0	1.64
AGOSTO A	33.98	42.9	19.5	18.22	41.15	17.7	92.7	1.45
VERANO	33.26	43.1	18.1	52.89	133.47	34.1	243.4	4.84
SEPTIEMBRE S	32.34	43.1	19.1	16.85	71.41	35.5	23.0	2.80
OCTUBRE O	28.78	41.5	14.5	14.17	15.69	4.5	0.7	0.62
NOVIEMBRE N	23.29	39.1	0.	10.28	10.93	2.0	2.5	0.48
OTOÑO	28.14	43.1	0	41.30	98.03	42.0	26.2	3.90
ANUALES	26.56	43.1	0		435.32	183.9	721.0	
Indice anual de eficiencia de la temperatura				153.02				
Indice anual I de precipitación efectiva								28.29
% de concentración térmica en el verano				34.56				

CLIMA DE ACUERDO CON THORNTWAITHE D (o) A' (b')

D= Seco, (o)= Con otoño seco.
A'=Cálido (b')= Con invierno benigno.

ESTADO DE NUEVO LEON. ZONA No. 3

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE (Atlas Meteorológico)

MONTERREY.

214-7

MESES (Month)		°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i)' DE EFICIENCIA DE LA TEMPERATURA	mm. (Rainfall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 19----	TOTAL EN EL AÑO MAS HUMEDO 19----	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE	D	14.2			4.86	23.7			1.6
ENERO	J	14.4			4.96	21.7			1.5
FEBRERO	F	16.8			6.26	23.1			1.4
INVIERNO		15.1			16.08	68.5			4.5
MARZO	M	19.6			7.91	15.5			0.7
ABRIL	A	23.2			10.21	28.7			1.3
MAYO	M	25.6			11.85	42.0			1.9
PRIMAVERA		22.8			29.97	86.2			3.9
JUNIO	J	27.0			12.85	84.6			3.8
JULIO	J	27.2			12.99	72.9			3.3
AGOSTO	A	27.9			13.50	62.6			2.7
VERANO		27.4			39.34	220.1			9.8
SEPTIEMBRE	S	25.4			11.71	204.6			10.9
OCTUBRE	O	22.3			9.62	109.6			6.0
NOVIEMBRE	N	17.6			6.72	25.5			1.5
OTOÑO		21.8			28.05	339.7			18.4
ANUALES		21.8	41.5	- 5.4		714.5			
Indice anual de eficiencia de la temperatura					113.44				36.6
Indice anual I de precipitación efectiva									
% de concentración térmica en el verano					34.68				

CLIMA DE ACUERDO CON THORNTWAITHE C (r) B' (b')

C= Semi-seco, (r)= Sin estación seca bien definida.
B'=Semi-cálido, (b')= Con invierno benigno.

ESTADO DE NUEVO LEON. ZONA No. 4

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE ___(Atlas Meteorológico)_____

Linares.

214-7

MESES (Month)	°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i) DE EFICIENCIA DE LA TEMPERATURA	mm. (Rainfall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 19_____	TOTAL EN EL AÑO MAS HUMEDO 19_____	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE D	14.3			4.91	31.3			2.1
ENERO J	14.8			5.17	29.8			1.9
FEBRERO F	17.3			6.55	15.5			1.0
INVIERNO	15.5			16.63	76.6			5.0
MARZO M	19.3			7.73	19.4			0.9
ABRIL A	23.1			10.15	52.1			2.4
MAYO M	24.9			11.37	92.5			4.5
PRIMAVERA	22.4			29.25	164.0			7.8
JUNIO J	26.4			12.42	99.8			4.7
JULIO J	26.8			12.70	99.3			4.5
AGOSTO A	27.5			13.21	61.5			2.7
VERANO	26.9			38.33	260.6			11.9
SEPTIEMBRE S	25.4			11.71	188.4			9.8
OCTUBRE O	22.7			9.88	80.4			4.1
NOVIEMBRE N	18.0			6.95	30.8			1.7
OTOÑO	22.0			28.54	299.6			15.6
ANUALES	21.7	42.3	- 5.0		800.8			
Indice anual de eficiencia de la temperatura				112.75				40.3
Indice anual I de precipitación efectiva								
% de concentración térmica en el verano				40.0				

CLIMA DE ACUERDO CON THORNTWAITHE C (r) B_1' (c')

C= Semi-seco, (r) Sin estación seca bien definida.
B_1'=Semi-cálido, (c') Extremoso.

ESTADO DE COAHUILA. ZONA No.5

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE (Atlas Meteorológico)

Múzquiz.

214-7

MESES Month	°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i) DE EFICIENCIA DE LA TEMPERATURA	m m. (rainfall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 19----	TOTAL EN EL AÑO MAS HUMEDO 19----	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE D	13.4			4.45	26.9			1.9
ENERO J	15.1			5.33	24.2			1.5
FEBRERO F	16.5			6.10	11.6			0.7
INVIERNO	15.0			15.88	62.7			4.1
MARZO M	18.7			7.37	26.0			1.4
ABRIL A	23.5			10.41	26.8			1.2
MAYO M	25.7			11.92	88.5			4.3
PRIMAVERA	22.6			29.70	141.3			6.3
JUNIO J	28.4			13.87	78.6			3.3
JULIO J	28.8			14.17	63.3			2.6
AGOSTO A	29.3			14.54	78.6			3.3
VERANO	28.8			42.58	220.5			9.2
SEPTIEMBRE S	27.4			13.14	176.9			8.6
OCTUBRE O	24.0			10.75	72.5			3.7
NOVIEMBRE N	17.9			6.90	28.5			1.6
OTOÑO	23.1			30.79	277.9			13.9
ANUALES	22.4	49.0	- 9.0		708.4			
Indice anual de eficiencia de la temperatura				118.95				
Indice anual I de precipitación efecti								34.1
% de concentración térmica en el verano				35.80				

CLIMA DE ACUERDO CON THORNTWAITHE C (r) B' (c')

C= Semi-seco (r)= Sin estación seca bien definida.
B'= Semi-cálido (c') Extremoso.

ESTADO DE COAHUILA. ZONA No.6

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE (Atlas Meteorológico)

Presa Dn. Martín.

214-7

MESES (Month)		°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i) DE EFICIENCIA DE LA TEMPERATURA	mm. (Rainfall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 19-----	TOTAL EN EL AÑO MAS HUMEDO 19-----	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE	D	12.8			4.15	24.8			1.8
ENERO	J	12.9			4.20	28.6			2.0
FEBRERO	F	15.3			5.44	19.9			1.3
INVIERNO		13.7			13.79	73.3			5.1
MARZO	M	19.1			7.61	20.4			0.9
ABRIL	A	23.8			10.62	43.0			2.0
MAYO	M	27.1			12.92	50.2			2.1
PRIMAVERA		23.3			31.15	113.6			5.0
JUNIO	J	29.7			14.84	48.4			1.8
JULIO	J	30.7			15.61	31.8			1.2
AGOSTO	A	30.7			15.61	39.0			1.5
VERANO		30.4			46.06	119.2			4.5
SEPTIEMBRE	S	28.1			13.65	85.9			3.7
OCTUBRE	O	23.9			10.68	50.0			2.3
NOVIEMBRE	N	17.8			6.84	18.6			1.0
OTOÑO		23.3			31.17	154.5			7.0
ANUALES		22.7	44.4	- 7.4		460.6			
Indice anual de eficiencia de la temperatura					122.17				21.6
Indice anual I de precipitación efectiva									
% de concentración térmica en el verano					37.70				
CLIMA DE ACUERDO CON THORNTWAITE D (r) B' (c')									

Dr Seco, (r) = Sin estación seca bien definida.
B'=Semi-cálido, (c').-Extremoso.

ESTADO DE CHIHUAHUA. ZONA No.7

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE ----1924-33----

Cd. Camargo, Chih.

214-7

MESES (Months)		°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA		MINIMA EXTREMA		INDICES MENSUALES (i) DE EFICIENCIA DE LA TEMPERATURA	mm. (Rainfall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 1932	TOTAL EN EL AÑO MAS HUMEDO 1930	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE	D	15.8	43.5	26	- 8.0	32	5.71	18.3	2.0	24.5	1.00
ENERO	E	12.4	44.7	27	- 6.0	31	3.96	12.9	(11.4)	Inap.	0.87
FEBRERO	F	14.9	36.0	26	- 3.1	37	5.22	4.0	3.4	Inap.	0.28
INVIERNO		14.4	44.7		- 8.0		14.89	35.2	16.8	24.5	2.15
MARZO	M	17.3	38.0	25	- 4.0	29	6.55	4.7	3.5	35.0	0.28
ABRIL	A	21.0	43.0	25	- 1.6	28	8.78	5.2	Inap.	0.5	0.25
MAYO	M	25.5	45.0	25	7.0	30	11.78	8.7	Inap.	14.8	0.40
PRIMAVERA		21.3	45.0		- 4.0		27.11	18.6	3.5	50.3	0.93
JUNIO	J	30.1	47.6	29	12.0	Vs	15.15	23.8	4.5	60.0	0.88
JULIO	J	28.4	47.2	29	9.8	28	13.87	80.6	50.5	141.6	3.56
AGOSTO	A	27.3	44.0	24	14.0	30	13.07	49.6	59.0	51.5	2.18
VERANO		28.6	47.6		9.8		42.09	154.0	114.0	253.1	6.62
SEPTIEMBRE	S	25.5	44.2	26	10.0	24	11.78	49.7	65.0	16.0	2.45
OCTUBRE	O	21.6	40.0	25	- 2.0	29	9.17	34.0	20.5	101.0	1.75
NOVIEMBRE	N	15.8	43.7	26	- 6.0	29	5.71	11.6	0	37.0	0.68
OTOÑO		21.0	44.2		- 6.0		26.66	95.3	85.5	154.0	4.88
ANUALES		21.3	47.6		- 8.0			303.1	219.8	481.9	
Indice anual de eficiencia de la temperatura							110.75				
Indice anual I de precipitación efectiva											14.58
% de concentración térmica en el verano							38.00				

CLIMA DE ACUERDO CON THORNTWAITHE E (i p) ; B' (c')

E- Mu- seco (i p) invierno - primavera secos.
B'- semi-cálido (c') extremoso.

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE 23 años.

Ciudad Juarez, Chih.

214-7

MESES	°C TEMPERATURA MEDIA	°C TEMPERATURA MAXIMA ABSOLUTA	°C TEMPERATURA MINIMA EXTREMA	INDICES MENSUALES (i)' DE EFICIENCIA DE LA TEMPERATURA	mm. PRECIPITACION MEDIA	mm. PRECIPITACION TOTAL EN EL AÑO MAS SECO 1934--	mm. PRECIPITACION TOTAL EN EL AÑO MAS HUMEDO 1937---	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE	5.3	23.0	- 16.0	1.09	22.6	5.9	4.0	2.2
ENERO	5.4	23.2	- 14.5	1.12	6.2	Inap.	8.2	0.5
FEBRERO	9.8	26.0	7.5	2.77	9.5	13.9	14.8	0.6
INVIERNO	6.8	26.0	- 16.0	4.98	38.3	19.8	27.0	3.3
MARZO	11.7	32.0	- 6.0	3.62	7.5	9.3	0	0.6
ABRIL	17.4	37.0	- 1.5	6.61	7.3	0.8	4.0	0.5
MAYO	21.4	37.0	2.0	9.04	14.9	17.2	11.5	0.7
PRIMAVERA	16.8	37.0	- 6.0	19.27	29.7	27.3	15.5	1.8
JUNIO	26.0	41.0	10.0	12.13	11.3	6.7	17.5	0.3
JULIO	29.0	41.2	14.0	14.32	27.3	11.2	22.6	0.3
AGOSTO	25.9	39.8	11.5	12.06	37.0	11.4	7.8	1.7
VERANO	27.0	41.2	10.0	38.51	75.6	29.3	47.9	2.3
SEPTIEMBRE	23.3	36.2	8.0	10.28	28.6	3.2	37.0	1.3
OCTUBRE	17.0	34.6	- 2.5	6.38	25.4	20.0	21.7	1.5
NOVIEMBRE	10.4	27.0	- 8.0	3.03	12.9	7.8	175.1	0.9
OTOÑO	16.9	36.2	- 8.0	19.69	66.9	31.0	233.8	3.7
ANUALES	16.9	41.2	- 16.0		210.5	107.4	324.2	
Indice anual de eficiencia de la temperatura				82.45				
Indice anual I de precipitación efectiva								11.1
% de concentración térmica en el verano				46.71				

CLIMA DE ACUERDO CON THORNTWAITE E (i p v); B_2' (c')

E.-Muy seco (i p v) con invierno, primavera y verano secos
B_2' Templado (c') extremoso.

ESTADO DE CHIHUAHUA. ZONA No.9

DATOS DE TEMPERATURA Y PRECIPITACION

CORRESPONDIENTES AL PERIODO DE (Atlas Meteorológico)

Chihuahua, Chih.

214-7

MESES (Month)		°C TEMPERATURA MEDIA	MAXIMA ABSOLUTA	MINIMA EXTREMA	INDICES MENSUALES (i) DE EFICIENCIA DE LA TEMPERATURA	mm. (Rain fall) PRECIPITACION MEDIA	TOTAL EN EL AÑO MAS SECO 19____	TOTAL EN EL AÑO MAS HUMEDO 19____	INDICES MENSUALES (i) DE PRECIPITACION EFECTIVA.
DICIEMBRE	D	9.2			2.52	21.2			1.6
ENERO	J	9.6			2.69	3.8			0.3
FEBRERO	F	11.8			3.67	5.2			0.4
INVIERNO		10.2			8.88	30.2			2.3
MARZO	M	14.9			5.22	7.9			0.5
ABRIL	A	18.7			7.37	7.6			0.5
MAYO	M	23.1			10.15	10.6			0.4
PRIMAVERA		18.9			22.74	26.1			1.4
JUNIO	J	26.7			12.63	24.5			1.1
JULIO	J	25.1			11.50	79.4			3.8
AGOSTO	A	24.2			10.89	95.5			4.8
VERANO		25.3			35.02	199.4			9.7
SEPTIEMBRE	S	22.2			9.55	94.4			5.0
OCTUBRE	O	18.2			7.07	36.5			2.1
NOVIEMBRE	N	13.3			4.40	7.6			0.6
OTOÑO		17.9			21.02	138.5			7.7
ANUALES		18.1	38.5	-11.5		394.2			
Indice anual de eficiencia de la temperatura					87.66				21.1
Indice anual I de precipitación efectiva									
% de concentración térmica en el verano					39.95				

CLIMA DE ACUERDO CON THORNTWAITE D (i p) B' (c')

D= Seco, (i p)= Con invierno y primavera secos.
B'= Templado, (c') .-Extremoso.

SOME PROBLEMS OF THE TEXAS INDUSTRIAL WATER SUPPLY

RAYMOND K. CASSELL

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A cursory review of the literature on the subject of water supply in the State of Texas reveals the fact that from days of earliest settlement man has been thinking and writing about water. This is quite natural since the presence or lack of it largely governs his activities. Because the central theme which runs through all his writings on the subject has had to do with the quantity and economic availability of water, it will be treated likewise here.

In the consideration of the quantity of water in any area, the prime factor which must be dealt with, of course, is the source of supply. Precipitation or rain furnishes all the water over the land, whether it be surface water or ground water. The amount of precipitation which an area may receive depends upon its position with reference to the rain-bearing winds which blow from the sea, plus the local conditions which cause condensation to take place and precipitation to occur. In this respect the State of Texas, in the first instance, is situated in a peripheral position. Only the easternmost part of the state lies along the usual path of the moisture-laden winds that blow landward from the Gulf of Mexico. The occasional but unorderly east-west movement of these moist winds bring rain to the typically dry western parts of the state and at times has been responsible for the near arid conditions in the eastern parts of the state. In the second instance, the conditions which bring about condensation often are not present. In general, it can be said, therefore, that Texas comparatively, is not well blessed with rainwater.

In regard to the absolute quantities of precipitation in the state it may be noted that throughout its great east-west expanse Texas spans the wide belt which climatologists have classified as the transitional zone of the United States between the characteristically wet or humid lands and the typically dry or arid lands. On the average there are over forty inches of rain in the zone closest to the humid lands and as little as five inches of rain along the arid borders. In spite of this wide area range in the average annual rainfall there is enough water to support thirteen rather sizable streams which have a total annual average run-off of 37,000,000 acre feet, or enough water to cover the entire State of Florida to a depth of one foot.

It is not, therefore, the paucity of water which presents a problem in Texas. What may well one day amount to tragedy is the fact that almost 80 per cent of this run-off empties into the Gulf of Mexico virtually unused. The natural procedure to be followed in order to increase man's water supply would seem to be the construction of dams and impounding reservoirs which might be drawn upon in times of low rainfall. A few steps already have been taken in this direction. In conjunction with

efforts to control erosion and conserve the soils there have been set up thirty-one water conservancy districts. (Fig. 1, below.) While, in

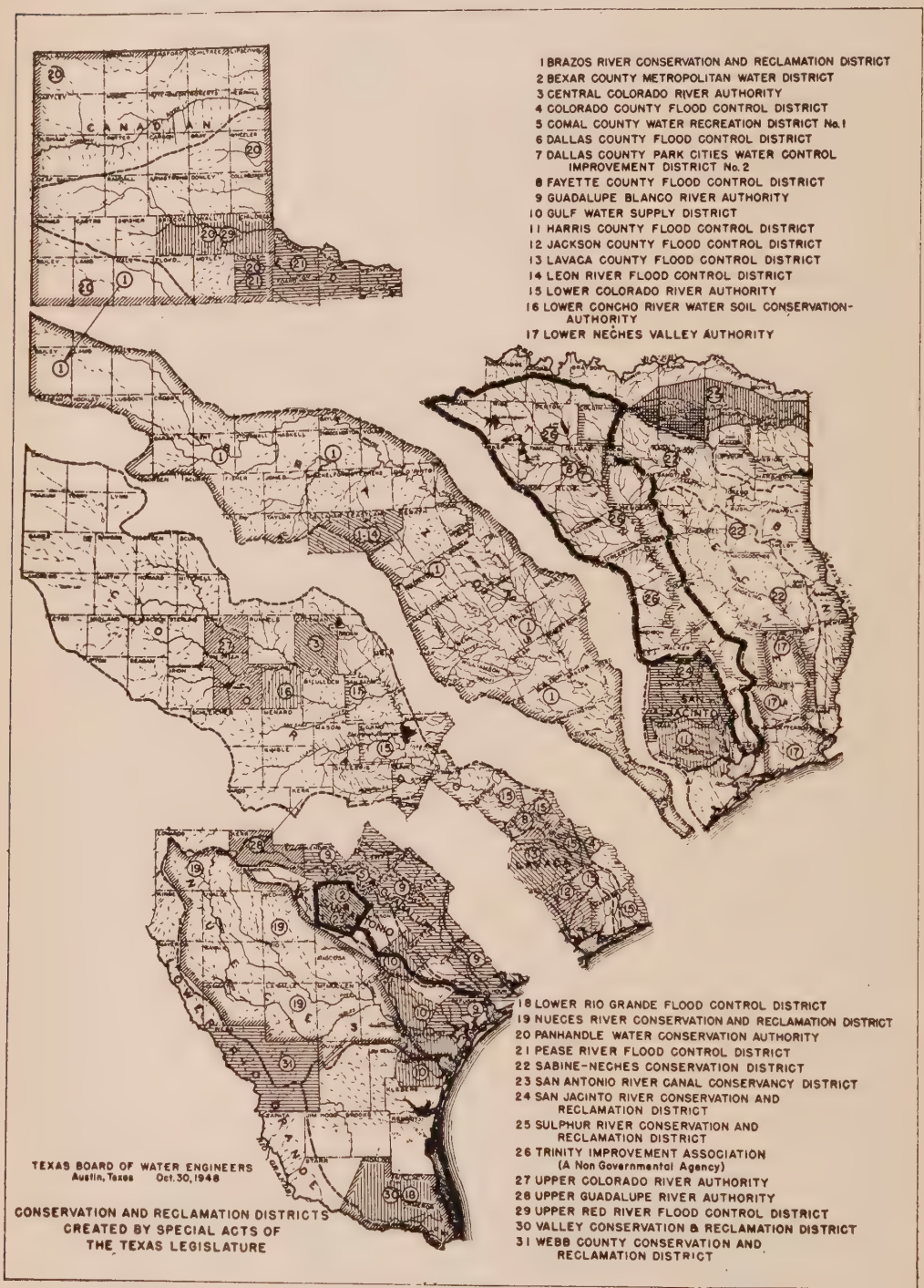

1 BRAZOS RIVER CONSERVATION AND RECLAMATION DISTRICT
2 BEXAR COUNTY METROPOLITAN WATER DISTRICT
3 CENTRAL COLORADO RIVER AUTHORITY
4 COLORADO COUNTY FLOOD CONTROL DISTRICT
5 COMAL COUNTY WATER RECREATION DISTRICT No. 1
6 DALLAS COUNTY FLOOD CONTROL DISTRICT
7 DALLAS COUNTY PARK CITIES WATER CONTROL IMPROVEMENT DISTRICT No. 2
8 FAYETTE COUNTY FLOOD CONTROL DISTRICT
9 GUADALUPE BLANCO RIVER AUTHORITY
10 GULF WATER SUPPLY DISTRICT
11 HARRIS COUNTY FLOOD CONTROL DISTRICT
12 JACKSON COUNTY FLOOD CONTROL DISTRICT
13 LAVACA COUNTY FLOOD CONTROL DISTRICT
14 LEON RIVER FLOOD CONTROL DISTRICT
15 LOWER COLORADO RIVER AUTHORITY
16 LOWER CONCHO RIVER WATER SOIL CONSERVATION-AUTHORITY
17 LOWER NECHES VALLEY AUTHORITY
18 LOWER RIO GRANDE FLOOD CONTROL DISTRICT
19 NUECES RIVER CONSERVATION AND RECLAMATION DISTRICT
20 PANHANDLE WATER CONSERVATION AUTHORITY
21 PEASE RIVER FLOOD CONTROL DISTRICT
22 SABINE-NECHES CONSERVATION DISTRICT
23 SAN ANTONIO RIVER CANAL CONSERVANCY DISTRICT
24 SAN JACINTO RIVER CONSERVATION AND RECLAMATION DISTRICT
25 SULPHUR RIVER CONSERVATION AND RECLAMATION DISTRICT
26 TRINITY IMPROVEMENT ASSOCIATION (A Non Governmental Agency)
27 UPPER COLORADO RIVER AUTHORITY
28 UPPER GUADALUPE RIVER AUTHORITY
29 UPPER RED RIVER FLOOD CONTROL DISTRICT
30 VALLEY CONSERVATION & RECLAMATION DISTRICT
31 WEBB COUNTY CONSERVATION AND RECLAMATION DISTRICT
TEXAS BOARD OF WATER ENGINEERS
Austin, Texas Oct. 30, 1948
CONSERVATION AND RECLAMATION DISTRICTS CREATED BY SPECIAL ACTS OF THE TEXAS LEGISLATURE

FIGURE 1

not a few of the districts, emphasis has been directed toward retarding the rate of run-off, in others significant strides have been taken to store water in order to meet increased demands and to warrant ample supply during the drier years. There are nine sizable storage reservoirs on Texas rivers with a total average storage capacity of about 2,500,000 acre feet, and upon completion of works now under construction, this capacity will be increased by one-quarter. Because water supply planners do not consider this amount adequate to take care of future requirements, federal and state agencies are at work gathering the basic data which must be available before the location and construction of reservoirs can begin.

The construction of dams in the future will present major problems. Naturally, they are built not only to conserve water but to control floods and to furnish hydro power. The selection of a damsite, where total cost of construction is not heavily outweighed by the total benefits to be derived, is a most involved process, especially so now that the better physically endowed sites in the state already have been taken. Except for the expense of building the Falcón Dam on the Rio Grande, now beginning, and the Canadian Dam project soon to be authorized, the costs of all other water impounding works hardly can be justified on a benefit basis unless there arises a phenomenal increase in water demands.

In several areas where water consumption is presently on the increase, apprehension prevails lest water shortages put a ceiling on continued growth, and consequently plans are currently being formulated for the construction of more storage water. For instance, Corpus Christi, chronically low in water reserves, is anticipating the construction of at least two more storage reservoirs on the Nueces system. Selection of structure sites present an economic problem, not so much because of the nature of the terrain, but because of the erratic and torrential character of the rainfall. Total impounding capacity must be unusually large in order to hold the great reserves which are needed to carry through the long periods of drouth. The rapid run-off incident to the very heavy downpours makes for a rapid silting up of the reservoirs so that expensive de-silting works may have to be installed.

The increase in water consumption plus the prospective decrease in the present water supply around Houston makes the construction of storage basins in that area seem imperative. If such installations were to be made in that immediate vicinity, tremendous costs would be incurred because an astronomical amount of earth would have to be moved in building impounding basins on this almost level terrain. Of necessity, to circumvent such costs, and in consideration of flood control and drainage, reservoirs will be built some distance from this heavy demand area.

To conclude these comments on the problems involved in increasing the water supply by controlling stream run-off, it may be noted that as future water demands grow, the United States Government through

its agencies, the United States Army Corps of Engineers and the Bureau of Reclamation (two highly competitive branches), will play an important part in solving these problems.

Before entering into the discussion of the underground waters of Texas, the author wishes to digress in order to make an additional remark upon the aforementioned Falcón Dam on the Lower Rio Grande River. This structure, not far from Zapata, Texas, will impound an international body of water, which will add very materially to the low water supply in that region. Further, in the field of international relations this water body will be a tying bond of everlasting friendship between the Republic of Mexico and the United States.

Not all of the water that falls on the land as rain or other forms of precipitation flows to the sea. In these latitudes considerable is evaporated. Considerably more seeps into the ground and saturates the subsurface. The amount of subsurface water, referred to as ground water, hereafter, that may accumulate in a given area depends upon the total amount of rainfall, the rate at which it falls, the rate of evaporation, the degree of slope, and the porosity of the soil. In some unconsolidated sedimentary strata sixty per cent of the volume is capable of holding water, while some hard compact rocks will hold no water.

Of the variety of factors influencing the quantities of Texas ground water, time and space will permit elaboration only upon the character and distribution of the water-bearing underground layers. Rock formations beneath the surface over most of the state are laid down in definite stratified layers. Some layers are porous and yield water, others are dense, tight, and impervious, and although some may be saturated, water cannot flow through them. The following description of the various rock formations will be designated through the use of geological nomenclature, and a summary of the water-holding capacity of the more important stratas is to be outlined.

Comparatively few formations or groups of formations furnish the greater part of the ground water developed in Texas. In the order of age from older to the younger they are as follows: The Trinity group and the Edwards and associated limestones, Lower Cretaceous; the Woodbine sand, Upper Cretaceous; sands of the Wilcox group and the Carrizo sand, lower Tertiary; the Catahoula tuff and sand, Oakville sandstone, and Lagarto clay, middle Tertiary; the Goliad-Willis sands and the High Plains deposits (Ogallala formation), upper Tertiary; the Beaumont clay; Pleistocene; and bolson and alluvial deposits, Pleistocene and Recent age. The accompanying map (Fig. 2) delineates boundaries of areas served by associated groups of formations. Since the seaward dip of a formation renders much of its water economically useless, because of increasing depth with increase in distance from the formation outcrop, the area of economically available water occurs only in narrow bands. To promote map clarity, rather than delimit

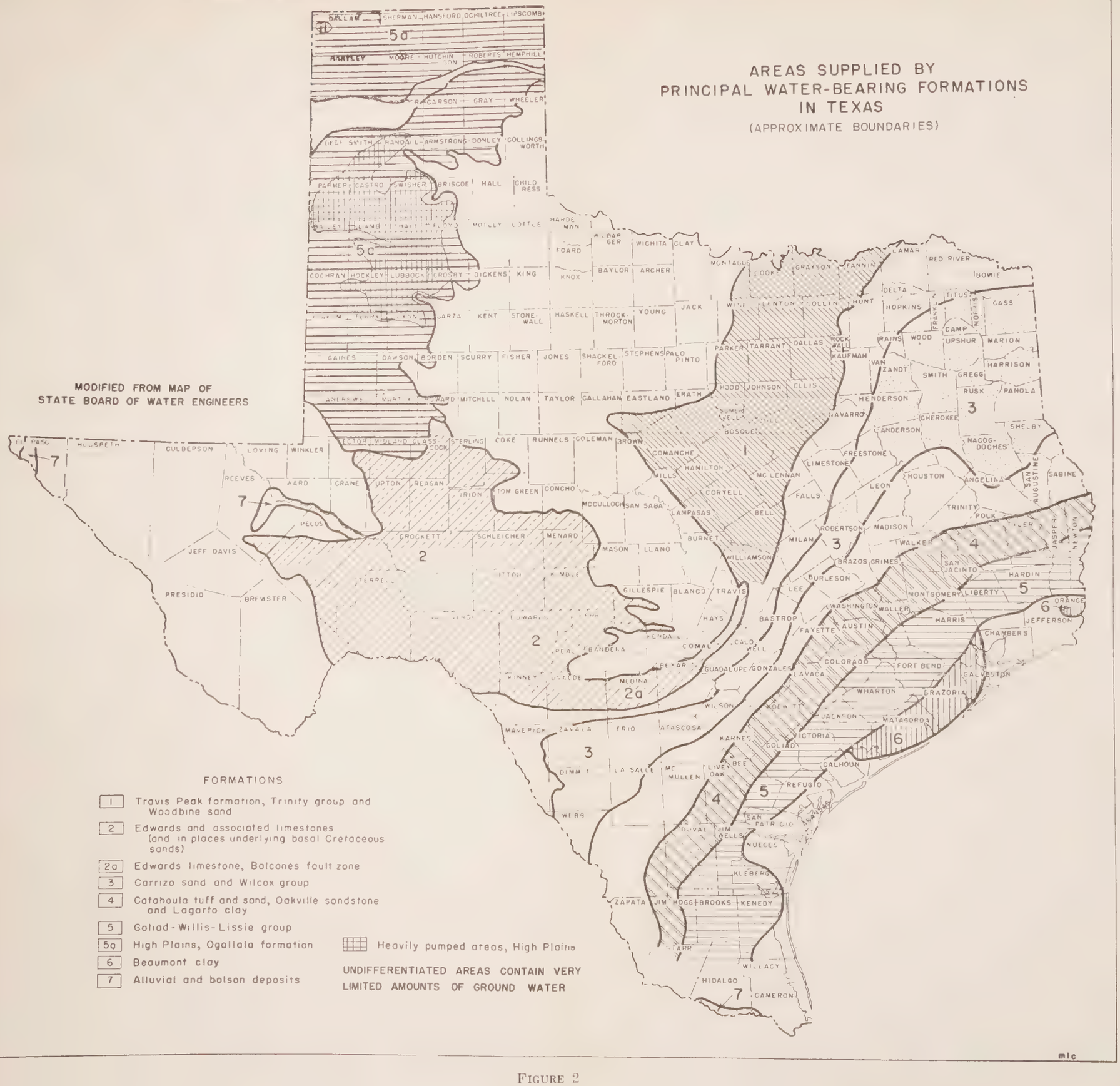

AREAS SUPPLIED BY
PRINCIPAL WATER-BEARING FORMATIONS
IN TEXAS
(APPROXIMATE BOUNDARIES)
MODIFIED FROM MAP OF
STATE BOARD OF WATER ENGINEERS
FORMATIONS
1 Travis Peak formation, Trinity group and Woodbine sand
2 Edwards and associated limestones (and in places underlying basal Cretaceous sands)
2a Edwards limestone, Balcones fault zone
3 Carrizo sand and Wilcox group
4 Catahoula tuff and sand, Oakville sandstone and Lagarto clay
5 Goliad-Willis-Lissie group
5a High Plains, Ogallala formation
6 Beaumont clay
7 Alluvial and bolson deposits
Heavily pumped areas, High Plains
UNDIFFERENTIATED AREAS CONTAIN VERY LIMITED AMOUNTS OF GROUND WATER
mlc

FIGURE 2

each area, they are grouped into associated formations and described accordingly.

In Area 1 (Fig. 2) the Travis Peak, Trinity group, and Woodbine sand formations are among the best underground water reservoirs in the state. Wells produce from 50 barrels per well per day to 200 gallons per minute and in few places as much as 600 gallons a minute. The well depths vary from a few feet to 1,200 feet, and thickness of the water-bearing beds range from 100 to 600 feet. The quality of the water is quite variable; in the Woodbine sands, where much oil is found, some of the water is unusuable. Most all of the cities and towns in this area obtain their domestic and industrial supplies from wells. Dallas, Fort Worth, Waco, and Temple are exceptions because of the tremendous urban demands.

Area 2 was one of the first ground water supplies discovered in Texas. Springs having their source in the porous Edwards limestone yield abundant supplies from Austin to Del Rio. Solubility of these limestones has permitted the formation of underground channels and reservoirs which contain inestimable quantities of water. Well depth ranges from 200 to 1000 feet. Like all water from limestone formations, this is highly mineralized and has to be treated by chemical or by the zeolite process for public water supply and some industrial uses.

Area 3, in a band of varying width, crosses the state from northeast to southwest. The Wilcox sands, located on the landward side of the area, are mixed with clays and lignite so that in extent and depth these water sands are unevenly distributed. Not highly developed in the northeast, yields have been low, but at Camp Swift, near Bastrop, about 5,000,000 gallons of water a day have been pumped. The quality of the water is regarded generally as good, but in several small areas of the Southwest it is so highly mineralized that it is often referred to as the mineral water belt. Situated on the seaward side of the Wilcox formation is the zone of Carrizo water sand. It ranges from a few feet to about 200 feet in thickness and consist of a course-grained, well-assorted, most permeable, and very porous uncemented sand. Sizable quantities in the northeast have been drawn only around Lufkin where 7,000,000 gallons a day are used. Some hydrologists estimate that this portion of the area has about the greatest potential ground water reserve in the state. Throughout the Southwest this sand formation is trapped between two impervious rock stratas so that when it was penetrated, it yielded an artesian flow. Overdevelopment caused all wells to cease to flow, and over pumping caused many wells to go dry. At present the ratio of water withdrawn to the ground water supply is so balanced that about 40,000 acres of land can be irrigated without difficulty.

Area 4 comprised of formations of tuff, sand, and clay, contains surprisingly uniform amounts of ground water. It should be noted, however, that in its southeastern extension each formation is more compacted and holds much less water than in the northeast. Well depth

varies from 100 to 1,200 feet from beds of indefinite thickness. Quality of water varies from rather heavy mineralization in the southwest to water of low chemical content in the northeast.

In Area 5(Fig. 2) the sands of the Goliad, Willis, and Lissie groups were thought to be the largest underground reserves in Texas. They are composed of thick beds of very permeable coarse sands and gravel. Artesian flow was characteristic when first developed, but combined consumption by irrigation, domestic, and industrial users was so great that artesian flow not only ceased throughout most of the area, but pumping depths increased with the growing withdrawals. Intensive ground water studies were carried out by the United States Geological Survey and the State Board of Water Engineers. By means of downdraw and recovery studies it was possible to predict within reasonable limits the volume of water which may be obtained from a given area. The factors upon which such predictions are made are the permeability, the coefficient of transmissibility, and the storage coefficient of the particular formation. By utilizing downdraw measurements in observation wells followed by measurement of recovery of the wells when pumping had ceased, it was possible to calculate the coefficient of transmissibility as well as the coefficient of storage. The term "coefficient of transmissibility" is an expression to describe the rate at which water will flow through the water-bearing formation under a specific hydraulic head. If the coefficient of transmissibility is high, water will flow readily through a formation; in other words, downdraw would be slow and recharge would be rapid. Since the outcrops of the watering-bearing sands in Area 5 are located in fairly humid lands, and the transmissibility coefficient is from medium to high, it would be deducted that adequate amounts of ground water are present to meet ordinary demands.

The High Plains of West Texas, Area 5a, have greater need of ground water than the remainder of the state principally because of inadequate rainfall and low run-off. Quite fortunately the area is covered by loose sedimentary sands and gravel which have high water-holding capacity. Therefore, much water has been stored in this formation. Low rainfall naturally means slow recharge, but with the high coefficient of transmissibility downdraw has been severe only where wells have been very closely spaced and quantities withdrawn numbering in millions of gallons per day per well. In the one million acre irrigated area with 8,500 wells centering on Hale County the water table dropped five feet during the year of 1948. Only with continued federal support policies will farmers be able to meet these increasing pumpage costs.

A short narrow band of land along the coast designated as Area 6 on the map (Fig. 2) is composed of sands and clays which are loose and pervious and therefore contain great quantities of ground water. Although at one time water was obtained by artesian flow, today the average well is 600 feet deep. Excessive pumping by several industrial users have, at times, caused serious drawdown consequences in the

area. But most serious is the high mineral content of a number of the deeper wells. In some the chlorine content has become so great that the water can be used neither for domestic nor industrial purposes.

The sand, silt, and clay deposits which are pocketed in the valleys and depressions of West Texas are water-bearing formations of note. The map (Fig. 2) locates only two of these. The bolson deposit north of El Paso, estimated at 4,000 feet in depth, yields great quantities of water. The army camp of nearby Fort Bliss uses an average of 25,000,000 gallons a day from this formation. Some Pecos River tributary valleys contain water-bearing sands which are only beginning to be developed. At Balmorhea, south of the Pecos River in Reeves county, there are a number of flowing springs issuing from a porous limestone formation.

It may be concluded from the foregoing discussion of surface and ground water that the distribution of water is not uniform in Texas, that quality of water varies from place to place, and that wise steps to be taken in order to meet future demands include a fuller use of surface supplies and conservation of ground water.

The relation of quantity and quality of water to industry is a very strong one. It has long been understood that water is the most important industrial material. No industry can operate without using water in some form at some point in its processes. Four general classes of uses may be recognized in which water owes its importance to its solvent action, its high latent heats in steam and ice production, its high heat capacity in heat transfer, and its mechanical properties as exemplified by the production of hydroelectric power, the operation of hydraulic presses, and other similar mechanical operations. The over-all long run consumption of water by industrial users far exceeds the quantities used by all other types of users. For example, industrial consumption in and about Houston is daily seven times greater than the amounts used for domestic purposes in Houston plus the great amounts which are used to irrigate the neighboring rice lands. The four main quantity users, chemical, petroleum, mining, and food processing industries around Houston, used 364,000,000 gallons daily in 1948.

The lack of large quantities of available water has restricted industrial growth at a number of places in Texas, and, in several, development is now in progress to increase the supply. To guarantee adequate amounts of water in the Houston area where pumping costs have been increasing as the water level in wells became lower, two industrial water canals were built to convey water from the nearby San Jacinto River, and the site for a proposed dam ot be built by the City of Houston on the river has been purchased. Corpus Christi is in negotiation with the United States Bureau of Reclamation with hope of getting that organization to build more dams on the Nueces River system. Fort Worth has recently voted a $12,000,000 bond issue to be used to augment the water supply. A number of industries have developed their own water resources such as the off-channel

impounding basins constructed by Dow and Du Pont and the sea-water channel built by Carthage Hydrocal along the Gulf coast.

Where water demands are great in a small concentrated area, water supply planners must take into consideration all classes of users because the demand of each effects the other. In one sizable Texas city not long ago a power company began expansion in order to meet present demands and to be ready for the future needs of power in the vicinity. In the process of that development the added use of water was in sufficient quantity so as to draw on the water supply of the domestic and industrial users whom it was then serving.

The usefulness of water for industry depends upon its quality. Industrial requirements vary from one industry to another and may be more rigid than domestic or irrigation requirements. Generally, industrial water should be free of suspended matter and dissolved salts of magnesium, calcium, and the heavy metals. It should not contain excessive amounts of salts of alkali metals or other disolved matter.

Suspended matter is objectionable wherever water is used. In cooling systems it clogs pipes and erodes vanes of turbines; in boilers it becomes a part of any scale that may be formed. In all washing operations, particularly those involving fibrous materials, it becomes firmly emmeshed in the material washed and prevents the completion of the washing operation. Process water for the food industry must, of course, be free of turbidity and bacterial contamination. Removal of suspended matter is effected by filtration, a process which adds materially to basic water cost where industrial quantities are concerned and is especially costly if it is present in quantities of more than 1,000 parts per million.

The effects of dissolved impurities in industrial water are so widely different in various operations that each would have to be discussed in connection with a particular use. Most all process water has to be chemically treated before use. Certain industries have special process requirements, such as low alkalinity and high sulfate hardness for brewing; zero hardness for canning peas and beans and for dairy wash water; odorless and tasteless for butter and cheese. Some food processing industries that use great quantities of water of low mineral content find it economical to locate plants near the pure water supply. While the methods and cost of removal of objectionable salts vary from industry to industry, there are none in Texas which are not concerned about the expense connected with the extraction of undesirable salts. Practically all surface water requires treatment, which may or may not include mineral removal. Ground water on the other hand, frequently does not have to be treated, but if it does, treatment is less expensive because of the greater uniformity in the mineral content and thus easier treatment control. It is little wonder that most industrial users prefer ground water to surface water since it is less turbid, less contaminated, and more uniform in mineral content and in temperature.

Last to be mentioned in this consideration of industrial water problems, but not the least important, is the problem of stream pollution that results from the disposal of industrial wastes into streams. Thirty years ago the petroleum refining industry had no waste problems. Refineries were of necessity located near a water supply, and that same supply became a convenient carrying medium for waste acid and soda. oil emulsions, and even the totally useless fraction which we now know as gasoline. Today, however, the congestion caused by expansion in the refining operations plus establishment of other industries in the refinery areas has created a difficult waste disposal problem, particularly since the river flow is not at all times great enough to handle the waste, and in some streams pollution loads approach saturation even in times of high water. Waste treatment studies are being carried forward, and Texas industries have accepted their responsibility to prevent development of a condition which today reacts not only to its own detriment, but to that of many other groups.

PLANNING THE HYDROELECTRIC DEVELOPMENT OF NORTHERN MEXICO

ALEJANDRO PAEZ URQUIDI

Director General, Federal Commission of Electricity, Republic of Mexico

In any discussion of basic industries in a given area, it is, of course, essential that the question of electric power resources be included. We have heard from the distinguished speakers that have preceded me in this conference, the discussion of economic factors, the availability of natural resources, and the problems of water for irrigation and industrial supply. It is now my privilege to present to you a panoramic picture of the hydroelectric development, both already existing and under project.

The geographical area to which I shall refer is limited to the northern states of Mexico and includes the states of Lower California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas.

As all of you know, the production of hydroelectric power requires the availability of either large volumes of water or water in small volumes but, in the latter case, at the same time, certain geological and topographical characteristics as will permit a drop of the small volume of

HYDROELECTRIC RESOURCES IN NORTHERN MEXICO

No.	Name	River	State	Flow Cubic Meters per Second	Head Meters	Capacity—Effective and/or Potential
1	San Antonio	Santo Domingo	Lower California	20	900	180,000
2	Angostura	Bavispe	Sonora	20	65	13,000
3	Alto Yaqui	Tutuaca	Chihuahua	50	450	225,000
4	Alto Yaqui	Aros	Sonora	50	200	100,000
5	Alto Yuqui	Yaqui	Sonora	50	350	175,000
6	A. Obregón (Oviachic)	Yaqui	Sonora	100	35	25,000
7	Salineta	Lower Conchos	Chihuahua	20	120	24,000
8	Rosetilla	Florido	Chihuahua	50	24.5	10,000
9	Kilometer 105	San Pedro	Chihuahua	12	7.2	1,000
10	Fco. I. Madero (Virgenes)	San Pedro	Chihuahua	31	11	5,000
11	Villalba	San Pedro	Chihuahua	7.3	54	6,000
12	Boquilla	Conchos	Chihuahua	40	62.5	25,000
13	Colina	Conchos	Chihuahua	20–40	12	3,000
14	Batopilas	Guachochic	Chihuahua	3	300	9,000
15	Cuauhtemoc	Verde	Chihuahua	20	?	?
16	Batopilas #2	Verde	Chihuahua	5	180	9,000
17	Ocamdo	Durazno	Chihuahua	3	100	3,000
18	Tragadero	Pilón	Nuevo León	1.3	100	1,300
19	Penita	Pilón	Nuevo León	2.3	260	6,000
20	Adjuntas	Pilón	Nuevo León	2.8	250	7,000
21	Ojeda	Pilón	Nuevo León	3.2	130	4,200
22	Boca	Pilón	Nuevo León	3.5	100	3,500
23	Nezquital #1	Blanco	Nuevo León	5	100	5,000
24	Nezquital #2	Blanco	Nuevo León	5	300	15,000
25	Guerrero	Salado	Tamaulipas	20	50	10,000
26	Falcón	Bravo	Tamaulipas	—	30	50,000

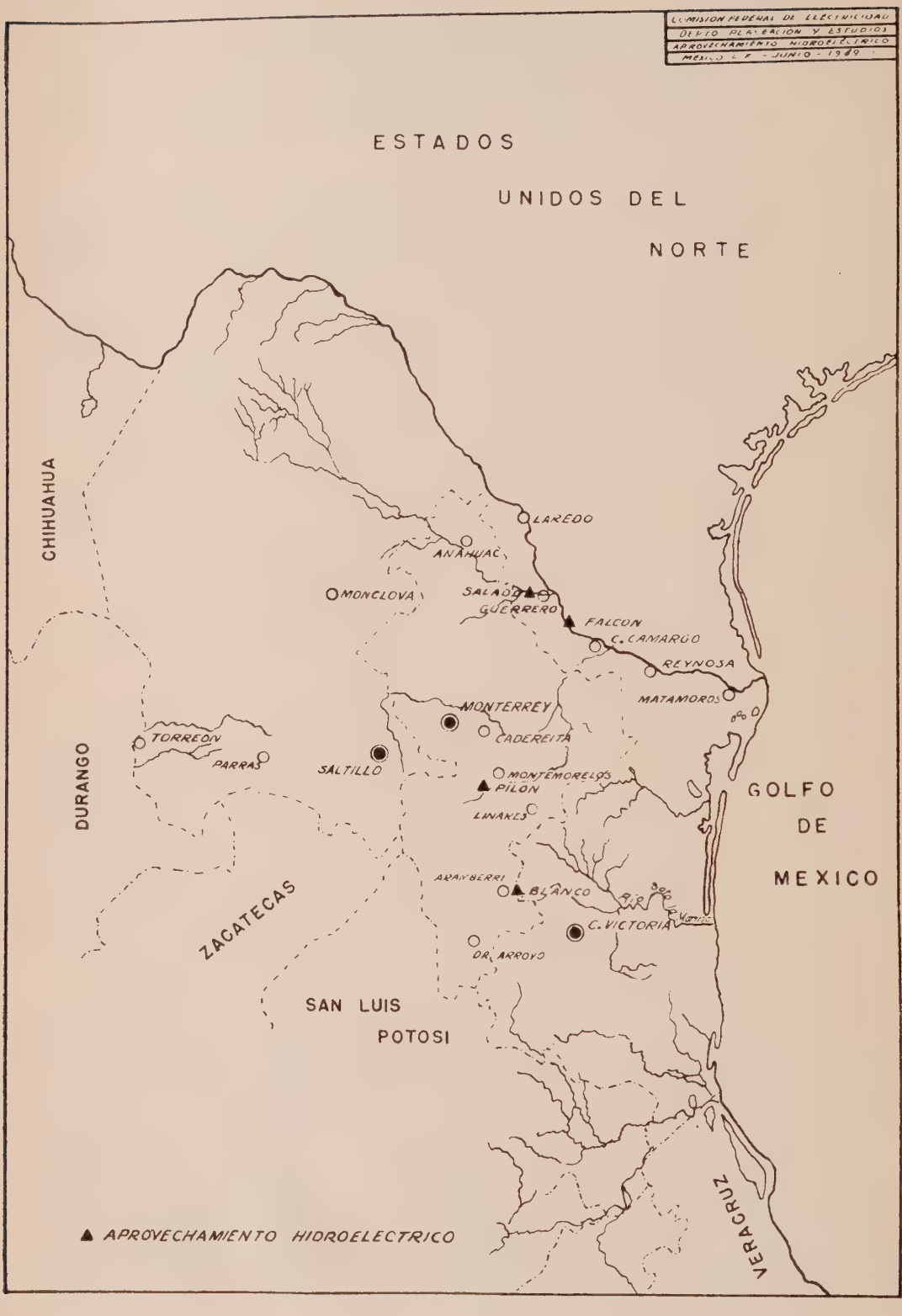
water available down a high "head" or difference in elevations. The only one of the six northern states of Mexico in which we find a combination of these two requirements in any appreciable amount is the State of Sonora, but, generally speaking, the principal sources of hydroelectric power in the Republic of Mexico are not to be found in the northern states.

One other very important requirement for the development of hydroelectric power, aside from the availability of water and of the proper kind of ground and topography, is the geographical location of the site with respect to the prospective centers of consumption of the electric power to be developed and also the lands that possibly could be irrigated and put to agricultural production. As we shall see further on, most of the potential hydroelectric developments in northern Mexico are located at such great distance from existing markets of electric power as to make the construction of some of them at this time, uneconomical from a purely financial standpoint. In other instances the lands available for agricultural development, either in the high plateaus or in the lower flat sections of the states, offer great possibilities for irrigation developments for agricultural purposes. In these cases the government is undertaking the largest program of irrigation works ever adopted in the history of Mexico. In so doing, new markets for electric power are being created automatically so that subsequently the supply of hydroelectric power produced in combination with some of the irrigation developments should become justifiable from an economic viewpoint.

Summarizing, we can say that so far as the hydroelectric development of the northern states of Mexico is concerned, Mexico is now engaged in the huge task of breaking a vicious circle. That is, the development of hydroelectric power in many instances now is not economically feasible because there is no market for electricity, while, on the other hand, there is no market for electricity because there is no electricity available. Therefore, by developing new lands for agriculture as a result of the irrigation projects now under way, new markets for electric power will be created, which, in turn shall make the construction of hydroelectric developments sound from an economic viewpoint.

Let us now review the hydroelectric possibilties in each of the six northern states of Mexico.

Starting from the Pacific Coast and working east, we first have the State of Baja California. The only important possibility for hydroelectric development that we know of is located in the northern part of the state on the San Antonio River, approximately 150 miles south of the United States-Mexico border. The San Antonio River here has a flow of 20 cubic meters per second, and it would be possible to produce a drop or head of 900 meters which would allow the development of around 180,000 kilowatts of electric power. There also exist possibilities of hydroelectric developments of lesser importance in the southern part of the State of


COMISION FEDERAL DE ELECTRICIDAD
DEPTO PLANEACION Y ESTUDIOS
APROVECHAMIENTO HIDROELECTRICO
MEXICO, D. F. - JUNIO - 1959
ESTADOS
UNIDOS DEL
NORTE
CHIHUAHUA
DURANGO
ZACATECAS
SAN LUIS
POTOSI
LAREDO
ANAHUAC
MONCLOVA
SALADO
GUERRERO
FALCON
C. CAMARGO
REYNOSA
MATAMOROS
MONTERREY
CADEREITA
TORREON
PARRAS
SALTILLO
MONTEMORELOS
PILON
LINARES
ARAMBERRI
BLANCO
RIO
SAN VICTORIA
C. VICTORIA
DR. ARROYO
GOLFO
DE
MEXICO
VERACRUZ
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Baja California, but no actual exploratory work has been undertaken up to now; consequently I have no figures at present.

Great strides are being taken in the development of agricultural activities in the State of Baja California: olive and grape plantations in great numbers are being developed; citrus fruits, vegetables and wheat are also being cultivated; in the mountainous section there are to be found minerals and fine woods. All of these activities have taken great impulse during the last five years and have created a demand for large amounts of additional electric power. It is not unlikely, therefore, that the development of the San Antonio hydroelectric project may become necessary in the very near future.

INSTALLED CAPACITY IN THE STATE OF BAJA CALIFORNIA, MEXICO

Number	Supplier	Location	Installed Capacity KW. Hydro	Steam	Internal Combustion	Total
1.	Cía. Eléctrica Fronteriza, S.A.	Ensenada			2,000	2,000
2.	Cía. El Boleo, S.A.	Sta. Rosalía		3,840		3,840
3.	Comisión Federal de Electricidad	La Paz			600	600
	5 small plants of 500 KW or less				371.5	371.5
	TOTAL			3,840	2,971.5	6,811.5

Comisión Federal de Electricidad
México, D.F., June, 1949.

Moving east we come to the State of Sonora which, as I said before, is where we find the largest possibilities of hydroelectric power development of any of the six northern states.

The backbone of the hydroelectric possibilities in this state is the Yaqui River which runs due south from the United States border and out to the Gulf of California on the Pacific Ocean side. On the Bavispe River, which is one of the main tributaries of the Yaqui River, the dam of Angostura already has been built for the purpose of regulating the flow of the waters of this tributary into the Yaqui River as a first step in the huge irrigation project of the lower valley around the City of Obregón. Construction is under way on the Obregón Dam, sometimes also called Oviachic, which will be the main regulating dam for the irrigation project. At both of these sites it will be possible to generate electric power. In the upper dam of Angostura there will be an average flow of 20 cubic meters per second with a head of 65 meters and a potential capacity of 13,000 kilowatts. In the lower dam of Obregón the flow will be considerably greater inasmuch as the Yaqui River at this point will have gathered the waters from its various tributaries; on the other hand the available head will not be as large as in the upper site. The flow at Obregón site will be 100 cubic meters per second, the head 35 meters, and the capacity of the electric plant 25,000 kilowatts.

We also find possibilities for hydroelectric power production on the upper Yaqui tributaries known as the Aros and Tutuaca rivers. The topography of the terrain in this area is such that it will permit the

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RIO BRAVO
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SINALOA
CHIHUAHUA
SONORA
BAJA CALIFORNIA
GOLFO DE CALIFORNIA
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development of relatively large heads at the three sites which have been studied. The Tutuaca River development would have a head of 450 meters, the Aros plant would have a 200 meter head, and the lower plant would have 350 meter head. In each plant there would be a flow of 50 cubic meters per second with a total potential capacity for the three plants of 500,000 kilowatts.

Adding up the total capacity of the five sites just mentioned we have a total of 538,000 kilowatts potential in the State of Sonora.

INSTALLED CAPACITY IN THE STATE OF SONORA, MEXICO

Number	Supplier	Location	Installed Capacity KW. Hydro	Steam	Internal Combustion	Total
1.	Cananea Cons. Copper Co.	Cananea		23,075		23,075
2.	Comisión Federal de Electricidad	Cd. Obregón			1,000	1,000
3.	Ferrocarril Sud-Pacífico de Mexico	Empalme			900	900
4.	Comisión Federal de Electricidad	Hermosillo			1,000	1,000
5.	The Moctezuma Copper Co.	Nacozari			5,808	5,808
6.	Cemento Portland, N. S.A.	Hermosillo			2,180	2,180
7.	Empresa de Servicios Públicos	Hermosillo			1,700	1,700
8.	Empresa de Servicios Públicos	Guaymas			1,055	1,055
9.	Empresa de Servicios Públicos	Cd. Obregón			1,390	1,390
10.	Empresa de Servicios Públicos	Navojoa			510	510
	43 small plants of 500 KW or less			1	1,107.3	1,108.3
	TOTAL			23,076	16,650.3	39,726.3

Comisión Federal de Electricidad
México, D.F., June, 1949.

The next state going east is Chihuahua. At the present time the State of Chihuahua is the one in which the largest amount of hydroelectric power already has been developed, so far as the six northern states of Mexico are concerned, the total effective hydro capacity already in service being 40,439 kilowatts as of today. The general topography of this state, especially of the eastern and northern sections of it, is such that it is not possible to develop high heads for hydroelectric power production. On the other hand the flow of its main river, the Conchos River, and that of its principal tributaries is not nearly as large as the flow in the rivers in the State of Sonora that we have just reviewed. Therefore, the potential development of hydroelectric power in the watershed of the Conchos River is less than 1/10 of that of the State of Sonora. Most of the possibilities for new development in this state are individually small, the largest one being the Salineta where there is a possibility of developing 24,000 kilowatts with a head of 120 meters and a flow of 20 cubic meters per second.

Further upstream we find the Rosetilla development already in operation with a total installed capacity of 10,000 kilowatts which, however, is not capable of continuous operation due to irrigation requirements absorbing a good deal of the available flow.

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MEXICO D JUNIO 1970
ESTADOS UNIDOS
DEL NORTE
TIJUANA
TECATE
MEXICALI
ENSENADA
EL ALAMO
STO TOMAS
S VICENTE
S TELMO
SALTO SAN ANTONIO
STO DOMINGO
S QUINTIN
ROSARIO
S FERNANDO
SONORA
GOLFO DE CALIFORNIA
STO DOMINGO
BAJA CALIFORNIA
S ROSALIA
S ANGUEDA
LA PURISIMA
COMANDU
OCEANO PACIFICO
LA PAZ
CARRIZAL
TRIUNFO
MIRAMONTES
APROVECHAMIENTO HIDROELECTRICO

On the San Pedro River, a tributary of the Conchos, we run into the irrigation dam and power plant at Kilometer 105, with an effective capacity of 1,000 kilowatts, and further upstream on the same river we have the Madero project, sometimes called Virgenes project, with a head of 31 meters, a flow of 11 cubic meters per second and a capacity of 5,000 kilowatts. Still further upstream there is the Villalba development with a head of 54 meters and a flow of 7¼ cubic meters per second giving a total capacity of 6,000 kilowatts. Further south and on the Conchos River we find the Boquilla and Colina plants already in operation, the first with an effective capacity of 27,600 kilowatts and the second with 3,200 kilowatts.

Preliminary studies made in the southwestern part of the state reveal the possibility of other smaller developments of hydroelectric power on the Guachochic and the Verde rivers as well as in the Durazno River with a total capacity of approximately 25,000 kilowatts. These developments, however, are individually small in size and therefore would be quite expensive, particularly due to the fact that they are located in the very abrupt section of the Sierra Madre Mountains and quite distant from the centers of consumption.

Summarizing, the practical possibilities for additional hydroelectric developments in the State of Chihuahua amount to 36,000 kilowatts, plus approximately 25,000 kilowatts in other developments not considered practical for several years to come.

INSTALLED CAPACITY IN THE STATE OF CHIHUAHUA, MEXICO

Number	Supplier	Location	Installed Capacity KW. Hydro	Steam	Internal Combustion	Total
1.	Cía. Agric. y de Fuerza Eléctrica del Río Conchos, S.A.	Sn. Fco. de Conchos	27,600			27,600
2.	Cía. Agric. y de Fuerza Eléctrica del Río Conchos, S.A.	Sn. Fco. de Conchos	3,200			3,200
3.	Cía. Agric. y de Fuerza Eléctrica del Río Conchos, S.A.	Rosetilla	9,600			9,600
4.	Minerales de Chihuahua, S.A.	Batopilas			1,200	1,200
5.	Minera Nacional, S.A.	M. Benavides			923	923
6.	Hermenejildo Hurias	Neoqui			2,100	2,100
7.	Mexicana Productora de Luz y Fuerza	Juárez		1,000	1,780	2,780
8.	31 small plants of 500 KW or less		39		1,518.5	1,557.5
	TOTAL		40,439	1,000	7,521.5	48,960.5

Comisión Federal de Electricidad
México, D.F., June, 1949.

Now we come to the State of Coahuila. A great deal of attention has been given to the discussion of basic industries in the State of Coahuila during this conference. However, when it comes to possibilities for hydroelectric developments, there is really nothing that can be said in favor of this state. The few rivers that fall within Coahuila are not important from the viewpoint of electric power generation; their flow is very small and there is no possibility of forming large enough heads for

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APROVECHAMIENTO HIDROELECTRICO
MEXICO D.F. - JUNIO - 1949 -
ESTADOS UNIDOS DE AMERICA
GOLFO DE MEXICO
OCEANO PACIFICO
ZONA NORTE
1.- San Antonio
2.-
3.- Alvaro Obregon
4.- Angostura
5.- Alto Yaqui
6.- Boquilla y Colino
7.- Rosetillo
8.- Fco. I. Madero
9.- Villalba
10.- Salineta
11.- Sierra Taronumara
12.- Pilon
13.- Blanco
14.- Guerrero
15.- Falcon
EN ESTUDIO
EN CONSTRUCCION
EN OPERACION
HERMOSILLO
GUAYMAS
LA PAZ
CULIACAN
DURANGO
MAZATLAN
MONTERREY
SALTILLO
C. VICTORIA
ZACATECAS
S. LUIS POTOSI
TAMPICO
GUADALAJARA
QUERETARO
PACHUCA
COLIMA
MORELIA
TOLUCA
MEXICO
TEXCOCA
PUEBLA
JALAPA
VERACRUZ
MANZANILLO
CHILPANCINGO
ACAPULCO
OAXACA
TUXTLA
VILLAHERMOSA
PUERTO ANGEL
MERIDA
CAMPECHE
CHETUMAL

power production. In other cases the geology of the terrain makes it impossible to build storage reservoirs because of the porous nature of the soil. Therefore, while much can be said in favor of the State of Coahuila from the viewpoint of other natural resources and of agriculture, there is nothing worthwhile mentioning regarding the possibilities of hydroelectric power. The source of power for this state is necessarily either from thermo electric plants within the state or from hydroelectric resources outside the state.

INSTALLED CAPACITY IN THE STATE OF COAHUILA, MEXICO

Number	Supplier	Location	Installed Capacity KW. Hydro	Steam	Internal Combustion	Total
1.	Cía. Combustibles Agujita, S.A.	Sabinas		750		750
2.	Altos Hornos de México	Monclova		11,500		11,500
3.	Carbón y Coke, S.A.	Sabinas		1,600		1,600
4.	Cía. Industrial de Parras, S.A.	Parras		1,400		1,400
5.	Cía. Carbonífera de Sabinas, S.A.	S. J. Sabinas		7,500		7,500
6.	Cía. Nacional de Electricidad	Sabinas		2,000	3,500	5,500
	12 small plants of 500 KW or less		498.5	300	1,239	2,037.5
	TOTAL		498.5	25,050	4,739	30,287.5

Comisión Federal de Electricidad
México, D.F., June, 1949.

The State of Nuevo León, wherein is located that industrious City of Monterrey about which our good friend Attorney Virgilio Garza gave us such an interesting talk last night, has a few streams the study of which reveal the possibility of developing a total of approximately 42,000 kilowatts. However, due to the irregularity of the flow in most of the streams and to the general topographical conditions found, there is hardly a single project which in itself would be economically justifiable to develop at the present time with perhaps the exception of the Blanco River in the southern part of the state where two plants with a total capacity of 20,000 kilowatts could be installed using a total head of 300 meters and a regulated flow of 5 cubic meters per second.

The other possibilities are found close to the City of Montemorelos on the Pilón River where small individual plants with heads varying from 100 to 260 meters each, and a flow of from 1.3 to 3.5 cubic meters per second could be built to produce a total capacity of 22,000 kilowatts.

We will say "adios" to Attorney Garza's home state and move east to the State of Tamaulipas which is the last of the six northern states of Mexico to be covered in my talk this morning.

The State of Tamaulipas is blessed with three rather important rivers which are the Panuco, down in the southern end of the state, the Guayalejo, or Tamesi, and the Soto la Marina River in the central part of the state. These three rivers, however, cross the State of Tamaulipas along the flatlands bordering on the Gulf of Mexico, many of which are also calcareous, therefore making it impossible to build artificial storage reservoirs for the production of hydroelectric power.

The only hydroelectric developments so far considered as practical within the State of Tamaulipas are to be found in the northern part of the state close to the Texas border.

INSTALLED CAPACITY IN THE STATE OF TAMAULIPAS, MEXICO

Number	Supplier	Location	Installed Capacity KW. Hydro	Steam	Internal Combustion	Total
1.	Comisión Federal de Electricidad	Nuevo Laredo		1,400	900	2,300
2.	Cía. Eléctrica de Tampico, S.A.	Tampico		13,920		13,920
3.	Comisión Federal de Electricidad	Cd. Victoria			1,000	1,000
4.	Cía. Eléctrica de Cd. Victoria, S.A.	Cd. Victoria			1,600	1,600
5.	Coop. del Ingenio del Mante	Cd. Mante		4,700		4,700
6.	Petróleos Mexicanos	Cd. Madero		600		600
	19 small plants of 500 KW or less		37.5	245	764.7	1,047.2
	TOTAL		37.5	20,865	4,264.7	25,167.2

Comisión Federal de Electricidad
México, D.F., June, 1949.

On the Salado River, tributary to the Bravo River (or Grande River as called in the United States) there exists a potential development of hydroelectric power with a capacity of 10,000 kilowatts using a head of 50 meters and a flow of 20 cubic meters per second.

The most important hydroelectric development possibility is to be found on the Rio Grande itself at the place known as Falcón. This particular development which will serve the multiple purpose of flood control, irrigation, and hydroelectric power production has been under active study on the part of the Comisión Internacional de Límites y Aguas Entre Mexico y los E.U.A. (United States—Mexico Limits and Water Commission). Two hydroelectric plants are being considered on the Falcón dam, one at each end and in each of the two countries. The total annual generation is estimated at 250 million KWH, half of which to be used in the United States and the other half in Mexico. Once the two dams upstream from the Falcón dam are built, it is estimated that it will be possible to develop up to 63,000 KW, but initially the maximum effective capacity of the two plants will probably not exceed 40 or 50,000 kilowatts.

Studies are under way on the part of the Mexican Commissioners to determine the ultimate utilization of the energy to be used on the Mexican side; that is, whether it would be preferable to supply the growing agricultural region of Reynosa and Matamoros to the east of Falcón, or to take the power into the State of Nuevo León as a possibility of supplying additional power to the Monterrey industrial and agricultural community. No decision on these two alternatives has been reached as yet.

Among the exhibits that you will find in the printed copies of this talk I have included statistics of the total installed capacity of hydroelectric, steam, and internal combustion generating stations located in each of the six northern states of Mexico which I trust you will find of interest. From said exhibits you will be able to see that the present installed capacity in

the six states amounts to 211,555 kilowatts. The potential new hydroelectric developments we have reviewed today add up to 831,000 kilowatts or, in other words, practically four times as much again as the total now in service in those states in all types of plants. Over and above the possible new hydroelectric developments, there is of course to be considered the addition of thermo electric plants in the six northern states, many of which are already under construction and shall be put in service within the next twelve months.

INSTALLED CAPACITY IN THE STATE OF NUEVO LEON, MEXICO

Number	Supplier	Location	Installed Capacity KW. Hydro	Steam	Internal Combustion	Total
1.	Cía. de Tranvías de Luz y Fuerza de Monterrey	Monterrey (Allende)		7,100		7,100
2.	Cía. de Tranvías de Luz y Fuerza de Monterrey	Monterrey (Bella Vista)		18,700		18,700
3.	Planta Eléctrica del Grupo Industrial	Monterrey		17,000		17,000
4.	American Smelting & Refining Co.	Monterrey		1,500		1,500
5.	Cía. Metalúrgical Peñoles, S.A.	Monterrey		2,250		2,250
6.	Fundidora Fierro y Acero de Monterrey, S.A.	Monterrey		10,296		10,296
7.	Coop. Cementos Hidalgo	Galeana		1,500		1,500
8.	Textiles Monterrey	Santiago	650			650
	27 small plants of 500 KW or less		575	275	756.9	1,606.9
	TOTAL		1,225	58,621	756.9	60,602.9

Comisión Federal de Electricidad
México, D.F., June, 1949.

Before giving you a chance to run out on me, I wish to avail myself of this opportunity to stress once more the policy that the Federal Government of Mexico, under the able guidance of President Alemán, is following in connection with the electrification of Mexico.

The Federal Electricity Commission is the agency of the Federal Government of Mexico entrusted with the planning and co-ordinating of the electrical development of the country. Likewise it is the developmental agency of electric facilities in Mexico. It is the policy of the Commission to collaborate with private initiative and to complement the development of electrical resources carried out by private initiative. It does not intend to compete with or to replace and absorb the operations of private initiative in the electrical field. Only to the extent that the public interest is not properly attended, whether it is because private initiative is not able or willing or may not have the necessary financial inducement to enter into a new situation or to expand their existing facilities, shall the Commission step in and take charge of the situation. I also wish to make public acknowledgment of the great co-operation and assistance given to Mexico for the carrying out of its electrical development by the Export-Import

Bank of Washington and lately by the International Bank for Reconstruction and Development, as well as by the Westinghouse Electric International Company, the International General Eletric Company, and the Aluminum Company of Canada. The credits granted to the Commission by these institutions represent approximately 40 per cent of the total investment in the projects that were and are being financed with the help of said institutions. An imoprtant part of the credits granted to the Federal Electricity Commission by them have been, in turn, passed on to private companies operating in Mexico; this is a tangible demonstration of the government's policy and attitude towards private capital in the electrical industry in Mexico. Thus we see that both within the country, as well as in Mexico's international relations, our great President is carrying on a constructive policy of co-operation and mutual understanding which is bound to be beneficial to Mexico and to the friends of Mexico.

THE *EL MANTE* REFINERY IN THE NATIONAL SUGAR INDUSTRY

JOSÉ CH. RAMÍREZ

General Manager, El Mante Sugar Refinery, Mexico

In accepting with a feeling of gratitude the honor bestowed upon me by The University of Texas through its invitation, I wish to state that I take it to be a friendly gesture of the directors of this center of learning, whose principal objective is to initiate and guide an interchange of relations between the United States of America and the Republic of Mexico, giving expression to the ideals of mutual, spiritual, and human comprehension.

There is no doubt that this progressive and futuristic program followed by The University of Texas is the most feasible in assisting the high political rapprochement among American countries, and in establishing co-operation in the hard task of international diplomacy directed towards peace in the universe in these trying days.

The system of spiritual and cultural interchange followed by this University is one of the best. It is an example to be imitated by all responsible men, making culture the medium through which all countries may co-operate for the successful achievement of peace and universal justice.

Having given my interpretation of this important event, I will now deal with the subject assigned to me. First let me state a few considerations with regard to the effort and work developed in Mexico under President Miguel Alemán, to insure its social welfare and to carry out great industrial and agricultural programs, without overlooking the fundamental educational program, to re-enforce the economic and cultural mediums that will make for happy, peaceful, and just living.

President Alemán has initiated the humane task of organizing agricultural and industrial centers, and he watches jealously that production be increased in order that Mexico may never lack means of subsistence and that the surplus may be sent to countries in need.

It is thus through this impulse that the best effort for the increase of production is being realized with governmental aid. Proof of this is the creation of four new sugar mills, namely:

Xiconténcatl, in the State of Tamaulipas, with a capacity of 50,000 tons of sugar per crop.

Sanalona, in the State of Sinaloa, with a capacity of 50,000 tons.

La Joya, in the State of Campeche, with a capacity of 10,000 tons.

Martínez de la Torre, in the State of Veracruz, with a capacity of 20,000 tons.

The sugar production in Mexico this year will be 636,000 tons, the internal consumption being approximately 520,000 tons; that is, 22 kilos 600 grams per capita a year.

The sugar market is regulated by the Federal Government through La Unión Nacional de Productores de Azúcar (National Association of Sugar Producers) which receives the sugar produced in seventy-four associated sugar mills; this union sells the product and finances the mills, the financing amounting to $164,549,891.00 yearly. This sum is realized after every crop upon the sale of the product. The sugar in turn is pledged by the above-mentioned union to the Banco de Mexico, S. A.

The alcohol produced by the sugar mills is delivered to the Sociedad de Productores de Alcohol, S.A. (Association of Alcohol Producers), this association having also semi-official control on the sale of alcohol.

The sugar mills in Mexico do not have a fixed market. All of their products are sold through the company above cited. For example, the Mante Sugar Mill of which I am general manager limits itself to shipping sugar to the places stipulated by La Unión Nacional de Productores de Azúcar, S. A., thus enabling the mobilization of this product to be done as cheaply as possible. It is because of this that Mante sugar is sold in its own State of Tamualipas and in the bordering ones of San Luis Potosí, Coahuila, and Nuevo León.

Of all Mexican industries the sugar industry is the best controlled—all of its functions being perfectly regulated by special laws which eliminate destructive competition.

Tables have been made, setting the prices for sugar and alcohol in accordance with their qualities or classes; this eliminates speculation. In regard to blackstrap, or final molasses, the prices are strictly subject to market prices and foreign demands. The prices of sugar are as follows:

$0.86 kilo retail for refined sugar.
$0.80 kilo retail for standard sugar (plantation white).

Since its foundation in 1521 by Hernán Cortés, the sugar industry of my country has suffered consecutive crises, due to the lack of balance between production costs and sale prices. To this we may add that our production was greater than our consumption. The first crisis was about 1822, during Iturbide's empire in Mexico, at which time the sugar production, located in its major part in the State of Morelos, under the auspices of the archbishopric of Mexico, was paralyzed. From 1926 to 1931, great economic convulsions which damaged the economy of the sugar industry took place. That same year La Unión Nacional de Productores de Azúcar was founded. This organization became the saviour of the industry, establishing economic stability among the producers, who have since prospered until a maximum annual production of 736,000 tons of sugar has been reached.

In 1930, the Mante Sugar Mill was established following a careful study of the possibility of growing cane with irrigation systems. The irrigation system of Mante was the second enterprise of its type constructed in the country.

The sugar mill was managed by Compañía Azucarera del Mante, S. A. until 1939, when the Cooperative de Ejidatarios y Obreros del Ingenio del Mante, S. C. L. took over its administration.

This Sociedad Cooperativa functions under regulations by precepts contained in the co-operative's law, which are based on the principle that both the workers and the farmers must co-operate—the first with manual labor, the latter with raw material.

The board of directors consists of the administration and vigilance assembly, an official organ called Establecimiento Público y Federal del Ingenio del Mante (Federal and Public Establishment of El Mante Mill) which is composed of representatives of the Secretariat of the Treasury, Nacional Financiera, S. A. This is due to the sale of the sugar mill to the government for $18,052,136.21, an amount to be reimbursed by annual payments of $2,014,426.00. When the co-operative has paid the total amount, the official intervention will be limited to that established by the law governing co-operatives by the Secretariat of National Economy.

This co-operative system, based on standards of common prosperity, was established in Mexico as a principle of social justice, there being a close similarity between this and the objectives of the International Labor Office, as practiced in England, France, Switzerland, and other countries, thus making effective co-operation possible and affording complete satisfaction in meeting all common needs. The founding of this system dates from 1895, when the Alianza Cooperativa Internacional was constituted, achieving great success when in France in the year of 1922 an International Cooperative Bank Committee was founded.

The co-operative system in Mexico has juridic standing. The essential rules fixed by the co-operatives themselves are that these must fill beneficial functions for productive associations.

The faults in actual practice are being corrected under the auspices of the federal government, which has the special task of establishing co-operatives in all such rural exploitations and enterprises as require considerable manual labor, thus making low production costs feasible.

In regard to co-operativism, mention may be made of the definition by Professor Paul H. Douglas, of the University of Chicago, who, in analysing the results obtained by the application of the system in various countries, said: "The co-operative improvement is one of the hidden wonders of the past 80 years, since it deals with a reunion of men that constitute a common enterprise that tries to obtain production objectives and social betterment and whose purposes are not to obtain greater profits, but to give the best service." The wonderful appreciation of Professor Douglas can be observed in the co-operative of the Mante sugar mill, in which its members, who number 2,772, enjoy all the possible economic advantages, binding themselves for their own convenience to furnish the type or class of manual labor that will best respond fully during each work cycle to cover the benefits that they require as well as the economic obligations of the business.

In the Mante sugar mill we have an efficient medical service, having a hospital with accommodations for 100 patients, attended by 17 doctors with laboratory service, radiology, tisiology, physiotherapy, pediatry, major and minor surgery, traumatology, orthopedy, maternity, odontology, eyes, ears, nose and throat, and social revision and hygiene, which takes care of a minimum of 10,000 patients.

It also has a co-operative store that sells to the workmen provisions and other articles at low prices. The workmen receive free of all charges: electric power, water, ice, housing, etc. The problem of lodging is now being studied for its integral solution, thus making it a general or common benefit that includes the farmers.

We have good primary schools, kindergartens for children, and rural schools; we have also built fields for sports, having furnished numerous equipment for different sports.

Mills for corn meal *(nixtamal)*, furniture, and other utensils for schools have been distributed; roads have been built; and in general, a series of benefits are made available which it would be tedious to enumerate. Nevertheless, I would not like to leave unmentioned the high school building now under construction. We have also a very good agricultural school to prepare the sons of the laborers for the work of the industry. For this type of study, the following subjects are being offered:

a) Fitotecnia.
b) Irrigation.
c) Agrology.
d) Land Surveying.
e) Parasitology.
f) Agricultural Economy.
g) Agricultural Equipment.

In regard to social services, the co-operative of the Mante sugar mill has the best in the country, special reference being made to the wage scale of the members. These are 72.24 per cent higher than those paid by any other sugar mill, since the other factories pay salaries in accordance with the labor law contract of the sugar and cane industry, which regulates the contractual relations between companies and workers. To the above must be added the loans made to workers, which imply considerable savings to the employees in the Mante sugar mill.

The Rio Mante irrigation district, which falls under the administration of the sugar mill, has 165 kilometers of canals, both main and secondary, 68 kilometers of drainages, and 205 kilometers of roads, with an irrigation capacity of 18.336 hectares of land dedicated to the cultivation of cane. We have decided to persist in the construction of larger mileage of drainage ditches and are working ardently on the interior drains for the cane fields to obtain the complete displacement of the excess waters and avoid deterioration of the plantings.

We have 10,000 hectares in full production and 4,200 hectares of new plantings, and propose to rotate with Sesbania Magracarpa and Kudzu

now being used extensively together with the green forage as a complement to increase organic matter in the soil. The sugar production in the Ingenio del Mante since its foundation is as follows:

Crop Year	Cane Tons
1930–31	(This crop was a trial and there are no records available.)
1931–32	156,904,813
1932–33	169,580,090
1933–34	233,166,910
1934–35	233,695,920
1935–36	229,852,730
1936–37	221,110,620
1937–38	291,160,170
1938–39	283,342,650
1939–40	277,739,230
1940–41	315,682,580
1941–42	412,266,610
1942–43	354,094,160
1943–44	303,094,820
1944–45	315,175,330
1945–46	305,047,660
1946–47	369,971,560
1947–48	495,338,260
1948–49	398,709,740

For the development of the field work, we have 1,849 farmer associates, and the necessary agricultural machinery which includes 46 tractors, 34 trucks, 67 plows, 4 dredges, and one ditching machine.

Our annual field yield has in previous years been up to 36 tons of cane per hectare, this having been increased to 42 tons per hectare, our present yield. We hope that the new systems now being used, which consist of better and more intense preparation of the soil, timely cultivation, and reasonable irrigation, our yearly field yield will be raised. It is felt that there is a possibility that for the agricultural cycle 1949–50 we may have a total crop of 460,000 tons of cane, and for the following year we may reach 500,000 tons, which will produce 55,000 tons of sugar.

We have definitely decided to persist in the great task of solving our original agricultural problem, unique in our country because of the quality of the soils and water. Since 1935, five years after the initiation of agricultural work, a rapid decline in the yields of the fields was noted, due, among other causes, to the deficient internal drainage of the soil and to the lack of adequate drainage of the irrigation district in general. Parallel to the above, it was noted that the lack of organic matter was also an important factor in the fertility limitation of the cane soils of the Mante, this being the reason why stubbles and trash are now left on the fields, and plants known as green fertilizer are cultivated. We have stopped the burning the fields, which eliminated the accumulation of the above expressed organic matter and which lowered considerably the yearly sugar yield.

The rocky formation underlying in the majority of the cultivated soils, originally called "choy," belonging to the Taylor formation, is composed of slate, lime, and sand, being impermeable and of heavy depth. The upper surface is found very close to the plowable soil, causing a deficient internal drainage and consequently the excessive accumulation of calcium and sodium salts, retarding the normal growth of the plant.

Unfortunately for us, the soils of the Rendzina group, to which ours belong, have not had enough study, and since these need special handling, we are necessarily obliged to do research at our experimental station founded recently. Its agricultural chemical laboratory is amply equipped for the analysis and classification of soils, waters, fertilizers, etc.

Precisely in the study of soils, our agricultural experiments tend to solve immediate problems, such as the procurement of adequate varieties of cane, the introduction of the new agricultural methods, irrigation, fertilization, etc., but always in accord with modern experimental methods.

Of the varieties of cane grown in the Mante region, 60 per cent corresponds to the P.O.J. 28–78, 20 per cent to C.O. 290, 8 per cent to C.I. 281, 2 per cent to P.O.J, 36, and 10 per cent to Cuba 48–72. In our experimental station we have a stock of cane, consisting of 102 species, but up to the present time we have not reached a definite conclusion. Nevertheless, we consider that within two or three years we will have the necessary data to guide our actions with regard to the better varieties of cane most suitable to the soils in our region.

In regard to agricultural defense, we have concentrated our attention in combating and controlling the Cane Borer *(Dyathrea Sacharalis)* which is the most important plague today in our region, without overlooking others such as *Tomaspis* and the *Chinche de Encaje,* which although of less importance than the borer, can cause considerable damages.

We have nothing definite as far as the methods of control, but we have made certain tests which in the present agricultural cycle will be continued with greater amplitude, preferably using mixtures based on "clorodano" which have given us better results for the original plagues than DDT, B-H-C and the Toxaphene.

Referring to cane diseases the only important one is the red-root *(Colethothrychum-Falcatum),* always appearing along the perforations made by the borer, although up to the present this has not been a major problem. There is no mosaic disease in this region.

A factor beneficial to our region is that the cane matures in twelve months, plantings being made from September to February. Cane cutting is initiated the third week of December.

Our transportation system for cane is by railroad and by trucks. Our railroad equipment consists of forty cars of the Ferrocarriles Nacionales (National Railroads) and 97 narrow gauge, these latter belonging to the

sugar mill; 250 trucks transport the major part of the cane. Our cane transportation is efficient.

The most serious problem of the Ingenio del Mante is the personnel for cutting the cane, due to the large demand of hand labor in that region, originated by new activities, such as the Ingenio de Xicoténcatl Sugar Mill, only 30 kilometers from Mante, as well as the harvesting of vegetables. Nevertheless, we have in perspective the acquisition of mechanical cane cutters with which we are now experimenting for cutting and stripping, since this is essential so as not to lower our annual yield of sugar.

The technical methods followed in cane cultivation are in accord with those well known in the sugar world, but its full application will not be possible until positive results are achieved in our experimental agronomic station which has been functioning since the first of May of this year. We are concentrating our efforts for the time being in applying efficient practices which heretofore had been only partially used due to the scarcity of directional elements.

Actually we have four agricultural engineers of recognized ability, who co-operate with the administration of the co-operative, and help us to put into practice our program of agricultural improvements.

As emergency measures until the experimental results will permit us to use better procedures, we are attempting to improve yields in the fields as follows:

a) Reducing our cycle of vegetation of the cane to two cuts, plant and ratoon, 26 months.

b) Mechanizing efficiently and totally all agricultural activities.

c) Timely planting with selected seed.

d) Adding organic matter, leaving the stubble and trash and intercalating green forage.

e) Providing sufficient irrigation.

f) Draining conveniently the individual cane fields and the irrigation district in general.

g) Fertilizing in accordance with the nature and types of soils that integrate the cane zone of the Mante.

To amply describe our agricultural system would be tiresome. That is the reason for limiting the remarks to the above explanations, especially since the purpose of the meeting is to present the problems and their solutions. It may be convenient to state that we are striving to improve the human element dedicated to the planting of cane to achieve more efficiency with our work and by this means obtain larger and better annual yields and, therefore, greater economic benefits for the farmers.

One of the fundamental preoccupations of the administrative direction of the Mante sugar mill is to establish working conditions more adequate to standard technical practices, and to achieve finally a total mechanization of cane agriculture, thus doing the work more rapidly and lowering the costs.

As regards the industrial aspect, we have two factories, one for refined sugar and the other for high quality alcohol. With reference to the sugar factory we are happy to state that it is perfectly organized, having responsible and efficient laborers, and that notwithstanding the nineteen years during which it has been operating without a single interruption, it has maintained a high standard of efficiency in its work due to the factors above mentioned and the constant attention on the part of the administration and technical direction to implant modern methods of elaboration and to acquire equipment necessary to all modern factories. The plant has 696 workers, 113 employees, and nineteen foremen and chiefs.

The milling equipment is composed of two sets of revolving knives operating at 504 and 600 RPM respectively; a crusher, 38″ diameter x 80¾″ long; and four three-roll mills, 35″ diameter x 78″ long, with which we can grind 3,200 metric tons of cane per day. This tandem is completely electrified, and compared with other similar mills in our country, makes an admirable showing, inasmuch as with cane having 13.5 per cent fiber, 93.2 per cent sucrose extraction is obtained. We are now studying the convenience of adding a fifth mill to improve our extraction.

We have six 900 H.P. boilers, five of which are sufficient to take care of the steam requirements of both factories; and one as stand-by for maintenance and repair. These boilers burn all the bagasse from the grinding or milling and eleven liters of fuel oil per ton of cane ground. With the improvements we plan to install in the near future, we expect to reduce our fuel oil consumption fifty per cent.

Our clarification system is of the most modern type, having been chosen in view of the fundamental importance which clarification has throughout the process of manufacture. H. P. control is effected with automatic micromax instruments, which assure more accurate and convenient liming of the cane juices.

The clarification station is complete with four juice heaters, having a total of 3,100 square feet of beading surface; three Dorr continuous clarifiers; two with a capacity of 37,000 gallons each, and one with a capacity of 33,000 gallons; two Oliver-Campbell cachaza filters, eight feet in diameter by twelve long, with 300 square feet of filtering surface each. The juice is weighed on an automatic Foxboro scale.

Our evaporation system is deficient; we have only 28,000 square feet of heating or evaporating surface in two quadruple effect evaporators. We shall in the near future increase the evaporating surface to 42,000 square feet, which will enable us to concentrate the juices better, thereby assisting the work in the vacuum pans as well as attain an important economy in fuel consumption.

The raw sugars are boiled in four calandria type vacuum pans, twelve feet in diameter each. A three-boiling system is used. The molasses from the last raw boiling (final molasses or blackstrap) is pumped

INGENIO DEL MANTE

ESQUEMA GENERAL DE LA ELABORACION DE AZUCAR

Dibujó: Alberto	Depto. de Maquinaria.
Revisó: J.P. Acosta	Diagrama de la Elaboración de azúcar del Ingenio del Mante.
Aprobó: L. López C.	
Escala: no	Dibujo no. Fecha: nov. 1967

1- Grupo Electrógeno - Con de 5.5 Tons. Motrices
2- Conductor Alimentador de Cañas - 58'.6"
3- Conductor de Cañas con Volteadores de Cargas, 68'.2".11"
4- Mesas de Cargas - Con. 80 Tons. Motrices
5- Conductor Intermedio de Cañas, 145'.5", 6'.6"
6- Cuchillas Nos. 1 y 2 de 500 y 600 R.P.M.
7- Una Desfibradora de 28", 600 H.P. Cuatro Motores de 35'.78"
8- Bombas del Duplex de Molinos:
A1- Bombas Intermedias de 75 G.P.M
B1- Bombas Guarapo de Doble Calentamiento de 275 G.P.M
9- Alimentadores de Bagazo No 1
10- " " " No 2
11- " " " No 3
12- Seis Calderas Acuotubulares - 900 B.H.P. C/u
13- Dos Compresores de Bateadas - 10'.5". 5"
14- Cuatro mesas Basculas de 5'.5" Diam.
15- Mezcladora de Cemento y Bagazo - 10'.2
16- Dos Fosfos Cuatro de 6' Diam x 42" - 300 m³ de Superficie de Petroleo
17- Basculas de Guarapo Crudo - Con 1340 Kgs
18- Tanque Receptor de la Basculas de Guarapo Crudo, Con. 11600 Lts
19- Tanque Mezcla No 1 - Con 19500 Lts.
20- Tanque Mezcla No 2 - Con 10500 Lts
21- Dos Bombas de Guarapo Crudo - de 675 G.P.M. y Dos Bombas de Guarapo Sulfitado - de 600 G.P.M.
22- Cuatro Calentadores de Guarapo de 3300 m² de Superficie tipo de Calentamiento

23- Tres Clarificadores - dos de 20' Diam y 140000 Lts y Uno de 18' Diam y 135000 Lts - de Cono Convencional 4%
24- Bombas de Lechada de Cal Diam - 325 G.P.M
25- Tanques de Almacenamiento de Cachaza - Con 4865 Lts
26- Bomba Telsis de Cachaza.
27- Tanques de Almacenamiento de Guarapo Clarificado - 28900 Lts
28- Dos Bombas para Guarapo Clarificado - 475 G.P.M 4%
29- Un Precalentador de 18' Diam y 4000 m² de Superficie de Calentamiento y Cuatro Efectos de 8' Diam y 2500 m² Son Calentamiento Superficie de Calentamiento
30- Un Precalentador de 18' Diam y 4000 m² de Superficie de Calentamiento y Cuatro Efectos de 8' Diam y 2500 m² de Superficie de Calentamiento
31- Dos Bombas para Meladura - 100 G.P.M
32- " " " " " "
33- Tanques para Meladura, Dos Cilindricos de 28900 Lts Cónicos 4% y Tres Rectangulares de 37600 Lts 4%
34- Cuatro Tachos de Meladura de 12' Diam, 2000 m² de Superficie de Calentamiento
35- Cuatro para la Meladura del Ultimo Meladura - 4000 Lts de Cap
36- Meladura para los Centrifugas de la Batteria "A"
37- Seis Centrifugas Electricas, Batteria "A" de 40" Diam x 24"
38- Un Transportador Helicoidal

39- Elevador de Cangilones para Pesos Moleculares
40- Tolva para Pesos Moleculares, de 26791 Lts de Cap
41- Transportador Helicoidal para de Pesos Moleculares
42- Tanques de Mezcla Moleculares, Tres Jarabes
43- Calderas de Pesos Moles
44- Dos Bombas para de Pesos Moleculares, de 115 G.P.M
45- Dos Tanques para de Tratamiento, de 25000 Lts de Cap 4%
46- Un Tanque para de Almacenamiento de 58500 Lts.
47- Una Bomba Centrifuga, de 115 G.P.M
48- Tanque Dosificadora
49- Cuatro Centrifugas Telescopicas "Tipo" de 18'.8"
50- Tres Tanques Mezcladores Cónicos de 25000 Lts 4%
51- Cuatro Centrifugas de Canastas de los Clarificadores Primarios de 24" de Diam
52- Tanque para Espuma, de 1400 Lts de Cap
53- Bomba Centrifuga de 50 G.P.M
54- Tanque Dosificadora
55- Dos Clarificadores Secundarios de 12'.6"
56- Cuatro para de Tanque de Cachaza, de 84" Diam
57- Cuatro para de Tanque de Cachaza, (Tipo de Clarificadores), de 24" de Diam
58- Cuatro Bombas Centrifugas para Cachaza 75 G.P.M 4%
59- Seis Abastecedores de 900 m² de Sup de Fumigación
60- Tanque de Almacenamiento de Licor de 19500 Lts de Cap
61- Dos Bombas para Licor, de 80 G.P.M 4%
62- Cinco Tanques de Almacenamiento de Licor, de 21300 Lts de Capacidad cada uno

63- Dos Tanques de Almacen, de 12' Diam x 8400 m² de Superficie de Calentamiento.
64- Un Mezcladora para Pesos Moleculares, 38600 Lts. Cap
65- Seis Centrifugas Electricas, Batteria Refinadora de 58500 Lts Cap y 40" Diam. 24" Alt
66- Un Transportador Helicoidal
67- Un Transportador Helicoidal Alimentador de los Tachos y del Equipo "Dorrco".
68- Un Equipo para Pesos "Dorrco".
69- Cuatro Tachos Mezcla para Pesos, 31000 Lts. Cap 4%.
70- Un Transportador Helicoidal
71- Elevador de Cangilones
72- Dos Tanques, Secadores Nos. 1 y 2 de 6'. 80'
73- Un Tanque Enfriadora de 6' Diam, 20'.
74- Elevador de Cangilones
75- Dos Centrifugas de Azucar.
76- Tanque Almacenamiento de Azucar Comercial - 875.00 Lts. Cap
77- Dos Basculas Automaticas de 50 Kgs. Cap 4%
78- Transportador de Bandas para Sacos de Azucar.
79- Tanque de Cachaza de 20500 Lts de Cap
80- Bomba Centrifuga de 75 G.P.M.
81- Cuarto para Pesos.
82- Ciclon para Pesos Tanque Enfriadora No. 3 - 7'.8" Diam
83- Dos Silos Construccion - 37400 Lts. de Cap
84- Tanque Almacenamiento Miscelaneo 26700 Lts Cap
85- Cuatro Centrifugas Electricas - 60" Diam. 84", Batteria "B"
86- Otras Centrifugas Electricas - 60" Diam. 84", Batteria "C"

87- Transportadores Helicoidales.
88- " "
89- Bascula de Azucar.
90- Dos Bandas Neumaticas de Mezcla Nos. 1 y 2 para Sacos.
91- Llenado de Sacos que van al Almacen
92- Almacen de 17500 Lts. de Cap.
93- Tanque Almacen de Azucar "C" - 2000 Lts. Cap
94- Bomba Alimentacion de 100 G.P.M.
95- Bomba Kinney Pesos "B"
96- Dos Tanques Almacenamiento de de Pesos B" - 37000 Lts Cap 4%
97- Bomba Kinney para Licores de la Batteria "B"
98- Tanque para Almacenamiento de Licores - 37000 Lts. Cap.
99- Dos Tanques para Almacenamiento de Pesos "A" - 37000 Lts. Cap.
100- Dos Bombas Kinney para Licores y Pesos de Alimentos.
101- Seis Tanques para Pesos y Licores de Refinerias de 21360 Lts. de Capacidad.
102- Bombas Dorrco Pesos Finos
103- Bascula para Pesos Finos - 5 Tons de Cap.
104- Tanque Recepcion de Pesos Finos - 5000 Lts. Cap
105- Bombas Kinney.
106- Tanque Almacenamiento para Pesos Finos - 1180 000 Lts Cap.
107- Dos Mezcladores de Cap - 8000 Lts. de Cap 4%
108- Sulfitadores.
109- Tanques de Guarapo Sulfitado
110- Medidor de Azucar.
111- Bombas Kinney para Pesos Batteria "A".

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to four steel storage tanks having a combined capacity of 7,240,000 liters, from which the alcohol factory is supplied or from which the molasses is shipped for export to the United States.

The raw sugars are then dissolved in a continuous melter and transferred to the refinery at a density of 30° Baumé. The melt is then treated hot with lime and phosphoric acid, which eliminates 40 per cent of the color. The treated melt is then transferred to Turl clarifiers which separate the cachaza (precipitated impurities) by means of aspirators, and the decanted liquid then undergoes a double treatment hot with Suchar activated carbon in special tanks. The activated carbon is separated from the Suchar treated melt in six autofilters operating in counter current double filtration. Each of these filters has 90 square feet filtering surface; the filtration being aided by the use of diatomaceous earth filter-aids. The filtered product, liquor, is of high purity, clear and transparent as water. This liquor is boiled in two refinery vacuum pans, 12′ in diameter, and with 2,100 square feet of heating surface, to crystallize refined sugar of high purity, using a four-boiling system. The boiled sugar, or refined massecuites are dried in six electrically driven, 40″ diameter by 24″ height, high speed centrifugals, which separate the molasses from the sugar crystals. The well refined sugar falls into distributing or classifying bins where the sugars are mixed prior to drying in cylindrical horizontal continuous feed dryers or granulators. The sugar discharged from the granulators is then transferred to the packaging department where the sugar is weighed in two automatic scales, and then bagged in 50 kilogram net weight bags. A small percentage of the well-refined sugar is transferred to the domino tableting machine for forming compact dominoes, which, after drying, are packed in special 25 kilo boxes.

It is with this technique used in the manufacture of sugar, which I have described in general terms, that we have obtained the best results in efficiency and yield, as may be noted from the following tabulation of the last ten crops:

Crops Year	Tons of Refined Sugar	Yield	Total Losses of Sucrose % Cane	Factory Efficiency
1938–39	28,500	10.1	2.3	97.1
1939–40	29,600	10.6	2.4	97.1
1940–41	33,500	10.6	2.2	97.4
1941–42	42,600	10.3	2.2	97.3
1942–43	38,800	11.0	2.2	97.6
1943–44	33,500	11.1	2.2	98.2
1944–45	35,700	11.3	2.1	98.1
1945–46	34,000	11.2	2.1	98.3
1946–47	39,800	10.8	2.0	98.7
1947–48	53,100	10.7	2.0	98.2
1948–49	45,206	11.3	1.98	99.3

We are striving to reduce costs of production and increase the efficiency of our equipment to reduce lost time as well as enable lower manufacturing costs.

The almost automatic manner in which process operations are carried on in a sugar factory would make many people think that the manufacture of sugar is almost a mechanical process, in which the only requisites are the important installations and equipment. However, all of these are mere visible accessories of the essential science of the manufacture of sugar, which is basically an entirely chemical process.

To indicate the importance which the chemical and technical factors have in the process, permit me to mention the reaction of the juices and molasses during elaboration. At the relatively high temperatures which the process requires, a high alcaline reaction would bring about destruction of reducing sugars present in the juice, along with the formation of highly melassigenic or gummy and detrimental substances. Therefore, during the many hours in process juices and molasses must be carefully controlled as to acidity and alcalinity.

Sucrose is present in the cane associated with many other substances which enhance the recovery of sugar and reduce the yield, as well as affect the quality of the sugar.

Sugar cane contains raw fiber, water, sucrose, reducing sugars (dextrose and levluose) organic acids, nitrogenous substances, and mineral substances. It also contains small quantities of pectins, wax, coloring matter, and sometimes starch.

The raw fiber is composed of cellulose, pentosane and lignin in variable proportions. The organic acids are mallic, suocinic, oxalic, gilcolic, tannic, aconitic, partly free, and partly as salts. The nitrogenous substances include allumina, peptone, aminoacids, amines and even a small proportion of nitrates. The mineral substances include silica, potassium oxide, calcium, magnesium, iron, aluminum, sodium, phosphates, chlorides, and carbonates.

The quantities of all these different constituents of the cane vary in ample limits and ranges, determined by multiple factors, depending upon the variety and ripeness of the cane composition of the soil, diseases and plagues of the cane, temperature, etc.

Because of the capital importance which chemistry has on the manufacture of sugar, El Mante maintains well-equipped laboratories with trained and experienced personnel.

In order to pay a just and fair price for the raw material delivered by the farmers, and at the same time to stimulate them to improve the quality of their canes, the cane is paid for on the basis of the factory yield.

We watch carefully costs of repairs and maintenance of the factory so as to restrict these to an indispensable limit, endeavoring, however, to maintain the equipment in normal good operating condition. On the other hand the Federal Government, through Nacional Financiera, S. A., has granted us a credit of $9,000,000.00 which we have earmarked exclusively for the acquisition of new equipment and machinery for the factory.

We do not intend to increase our grinding or milling capacity, since we feel that our factory is adequate for the production of raw material which can be produced within the Rio Mante irrigation system, as well as within the secondary irrigation system resulting from the pumping of excess waters of the district proper. We merely plan to substitute such of our apparatus as is in poor condition, and to install spares for our heavy equipment.

New machines, electric motors and locomotives have been purchased, and we plan to readapt our boilers, etc., for the purpose of completing our renovation program during 1951.

In regard to our costs of production, those, during the past three crops harvested by the Cooperative, have been as follows:

Zafra (Crop) 1945–46	$ 0.39466 per kilo of sugar
Zafra (Crop) 1946–47	0.37609 per kilo of sugar
Zafra (Crop) 1947–48	0.37717 per kilo of sugar

Having explained the conditions of the Ingenio del Mante Sugar Enterprise, it might be added that a praiseworthy effort is being made whereby a stable production of more than 40,000 tons of sugar will be assured, the economic equilibrium affirmed, and patrimony of the members of the co-operative society guaranteed.

I shall present an economic picture of the enterprise to give an idea of the development and results, but wish to state again that such results are only possible with a high production; otherwise a variation would be expected. The ciphers are as follows:

Cane Ground	Tons	Yield	Tons of Sugar
Of Members Agrarians	263,000	11.27%	29,600
Of Several farmers	122,000	10.05%	12,300
Of Cía. Río Guayalejo	110,000	10.05%	11,200
Total	495,000	10.73%	53,100
Sale and Cost of Products:			
Sale of 53,100 tons of sugar		$32,395,727.98	
Cost of cane—raw material	$17,508,434.45		
Industrial or Production cost	10,922,703.95	28,431,138.40	
Profit of sugar			$ 3,964,589.58
Sale of Alcohol:			
Excess from 1946–47 & Prod. of 1948	1,132,226.85		
Less Costs:	569,650.40		562,576.45
Sale of Molasses:	964,955.08		
Taxes	36,753.83		928,201.25
Other Yields:			
Miscellaneous	90,026.02		
Alcohol tins and boxes	173,317.14		263,343.16
TOTAL			$ 5,718,710.44

Cane Ground	Tons	Yield	Tons of Sugar
Several Losses:			
In Agricultural Machinery	$ 211,277.32		
Miscellaneous	82,446.18		
Irrigation District	221,294.81	$ 515,018.31	
Costs and Financial Products:			
Annual Interests of Factory	940,909.51		
Financing	821,123.73	1,762,033.24	
Reserves for bad accounts		878,065.92	$ 3,155,117.47
			$ 2,563,592.97
Expenses Social Provision		2,151,096.54	
Less: Fund Social Provision		43,694.05	2,107,402.49
			$ 456,190.48
Distribution of Net Yields:			
Increase of Legal Reserve Fund		$ 1,925.00	
Increase of Social Provision Fund		43,694.05	
Reserve for Taxes		350,000.00	
Excess yields pending application		60,571.43	
		$ 456,190.48	

Ingenio del Mante has an estimated value of more than 40 million pesos. I consider it necessary to state that this investment should yield a profit of at least $3,600,000.00 taking as a basis 9 per cent profit on investment which is the usual net profit in Mexico, excluding its income tax. Hence a profit of $456,190.48 does not represent any handsome sum.

Although this amount is low, it must be considered that the sum fixed for covering the annual debt to Nacional Financiera, S. A. to pay for the sugar factory must be added. Thus the enterprise is balanced as a business, despite the large expenses for social services, the irrigation district, agricultural machinery, etc.

The Mante Sugar Factory as a business, fulfills amply the functions above mentioned, *i.e.*: not to make more profit, but to serve better.

In the Mante Co-operative, the objective is to attain the independence of its members, once the obligation is fulfilled with the Government to pay the value of the enterprise proper. As a primary objective, it is our purpose that the workers should receive earnings or profits through payment of higher salaries as well as better or higher prices for raw materials, aside from the social benefits which represent an important factor in the future of the members of the Ingenio del Mante co-operative.

The economic and social prosperity of the members of the organization in question constitute a most significant example for the future of similar organizations; inasmuch as, in spite of the fact that salaries and prices are regulated and controlled in other factories of the country, we enjoy advantages of great consideration over them and it may be stated that the co-operative at El Mante is worthy of emulation in the improvement of the economic social life of Mexico.

I wish to state frankly that we have not yet attained the conditions of responsibility and discipline demanded by co-operativism, but we shall struggle vigorously to achieve through education skill in the work and mutual understanding among the members of the co-operative so as to reap in a consolidated program the common welfare desired and determine the path to total economic independence with greater advantages translated into terms of distributable profits and dividends, which shall be earnings adjusted to reality and concordant with the necessities of the members in its most ample sense.

The Government headed by President Alemán has undertaken the special task of stimulating the progress of the co-operative of Ingenio del Mante, as it has done with similar organizations, urging and giving an impetus to all the productive activities of Mexico. But the governmental stimulus would not be sufficient and would not be complete without the collaboration of the members of the Ingenio to overcome the complexities of the enterprise, which require the contribution of constant effort, intelligence, and everlasting confraternity.

In Mexico, co-operativism is becoming a force beyond discussion in the various branches of production. Many consumer co-operatives already exist and their common benefit is manifested by the rapid spread of the system in the national atmosphere. It is easy to foresee that very soon this type of economic-social organization will provide the assurances of a prosperity beyond discussion and the welfare of the community.

There are several other co-operatives in the sugar industry, besides El Mante. Such are Zacatepec in the State of Morelos, San Francisco Naranjal in the State of Veracruz, and Tuzamapán also in Veracruz. It can be affirmed that these co-operatives respond to their purpose with the natural inconveniences that the rest of the sugar factories suffer, wherein production costs do not permit reaching a maximum of efficiency because of the regulated and controlled prices of the product subject to internal market conditions, and heavy losses represented by foreign sales. The sales of sugar to England, United States, France, China, and Italy resulted in a total loss of $28,378,478.46 or $166.15 per ton of sugar.

The problem of the sugar industry has become more acute with the lack of a foreign market for alcohol, a situation which obliges us to export our excess of molasses at a derisive price, to be used as cattle feed, thus increasing the losses by a considerable percentage; this, the sugar factory must support because of the lack of foreign markets, constituting another discouraging aspect of the business. The Mexican sugar producers have plans for the utilization of the by-products, such as bagasse and blackstrap molasses.

In distributing the sugar in the national market heavy expenditures must be met for freights, commissions, taxes, bags and packaging, etc., which, added to the exportation losses, represent a heavy burden on the industry. Nevertheless this can be overcome if our entire output is

absorbed by national consumption, which as I have stated before, is being urged and impelled by the government of my country. Until such time as this is achieved, we are suffering considerable losses which affect the economic stability of the industry, which is in itself already burdened by several expenses which have increased by more than 40 per cent, taking as a basis the prices prevailing in 1948 for petroleum, spare parts, machinery, farmers' salaries, farm implements, and other accessories.

Conditions in the Mexican sugar industry can improve considerably in regard to prospective prices, thanks to the intense campaign which the Association of Sugar Producers is pursuing pro of sugar consumption. This campaign, added to the policy of President Alemán for the agricultural and industrial development, which includes roads, irrigation projects, etc., will make the per capita consumption increase from the present rate of 22 kilos 600 grams per year to 35 kilos.

The sugar activity in Mexico is one of major significance, embodying as it does, manufacturing and agricultural centers which combine the most favorable conditions of economic development and represent authentic foci of civilization. For example, there are to be found at every factory magnificent schools, decent centers of entertainment, sports fields and parks, hospitals, and an aggregate of institutions which furnish examples of the development of activities in the Mexican province.

At El Mante, we give preferred attention to the educational aspect, both as regards general culture as well as technical knowledge.

Numerous school buildings have been built, including one for secondary studies, and we have installed an excellent library. In regard to scientific teaching and research, we have just inaugurated the agricultural school and a chemical laboratory; these two institutions will serve not only the co-operative community of El Mante, but also the sugar industry of the country.

We are pledged to support the constructive task marked by the President, to reconstruct the entire irrigation district, and earnestly to foment and promote work on drainage, as well as on an adequate organization in all the branches of the administration of the co-operative. We are certain that our program will be a success.

The economic anomalities which prevail in the world considerably affect national credits, but our government has taken restrictive measures to avoid immoderate speculations and elevated circulation of money; thus it is being attempted to impede unfavorable repercussions in the cost of living. This foresight of the government is seconded by men of the sugar industry, who strive to increase production without presenting any problem as regards sales prices, even though these show a considerable disparity with relation to the prices of other articles of necessity, maintaining a low price for sugar in spite of the high manufacturing costs.

I have great faith in our national destiny, and I know that the sugar industry of my country will survive through a frank development of technical perfection. Thus by adequate standards of production, costs

will be reduced, and if to this we add the increase of national consumption, I feel that my frank optimism is well founded.

The Mexican sugar industry, under the auspices of President Alemán, initiated a reconstructive era in all its phases, and its progress parallels the boom which the Aztec nation is experiencing under the Alemán doctrine, which consists in excelling in work, and the methodical development of our natural wealth and resources. We are on the way to positive economic organization despite the barriers which have been caused by the financial disarrangements of the postwar.

The constant increase of the consumption of sugar in Mexico, which makes us believe in the perspective of certain stability in the sugar business, is a perfect index of the scale in which the factors of culture, health, nourishment, abundance of work in irrigation projects, roads, etc., and in general the economic development are being elevated.

The sugar industry of the world, with due recognition to the importance which the petroleum industry as well as others represent, is a symbol of all the activities of the peoples of the universe, and it constitutes a preoccupation in the conscience and mentality of man, be he an intellectual, technician in whatever branch, mechanic, economist, doctor, or teacher. This activity which I follow is the essence of the scientific spirit viewed from all angles, and in Mexico it is outstanding in the creation of social and economic values.

In my country, more than 150,000 families, dependent directly or indirectly upon it, have an interest in the sugar industry; they represent more than 700,000 rural inhabitants, all of whom unite in this great task of President Alemán, whose special preoccupation is that of dignifying the existence of the Mexican, leading us to happiness, resting our hopes in the common effort of the citizenry, and thus enabling us to be in condition to co-operate in the consolidation of the peace and tranquility of all beings in the world.

In discussing the subject assigned by The University of Texas, I have imposed upon your kindness, expounding general points and aspects of the sugar industry of my country; and I wish to present my apologies. I wish also to express my sincere appreciation for the many courtesies extended to me.

I would like to close my remarks with a plea for the continuation of the great work of rapprochement which this important University is carrying on, and I pray that it will bear fruit for the sake of the mutual understanding of all the people of this hemisphere, extending to the entire world as a message of harmony. I plead also that the struggle for the welfare of all men be continued and that very soon human confraternity may reign to end confusion and chaos.

Placeholder